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# **Expertise and the Own-Age Bias in Face Recognition**

A thesis submitted for the degree of Doctor of Philosophy

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**June 2011**

## Acknowledgements

Firstly, I would like to thank my supervisor Graham Hole. I would not have been able to complete this without him. He sparked my interest in face recognition and provided the inspiration for many of the studies in this thesis. I cannot say thank you enough.

To my office mates Ruth, Elin, Ee-fan, and Rachel for making my PhD so much fun! Thank you for all of the distractions; all the freddos, hippos, scrabble games, and tea breaks. I will miss you all... especially Johnny Depp, who only has eyes for me. Obviously.

To Zoe, I don't even know where to begin... thank you for being such a great friend, you have made my time at University so much fun. My PhD would not have been the same without you. And Jim, Gerrit and Martin, my liver would not be in the state it currently is without your influence.

A very special thank you to Dave, Ryan, Liz and Alison for all of their encouragement and support. And a massive thanks to Andy, Luke, Sam and Tom for putting up with my dulcet tones and teaching me to love Led Zepplin and songs with inappropriate lyrics! ☺ To my friends from the Shire and to the sunny Sydney-siders, you know who you are, thank you for supporting me and encouraging me outside of University life. Seb – I don't know what I would have done without you! Rich – ditto.

To all the students and teachers who volunteered to take part in my studies. This research would not have been possible without them.

And last, but definitely by no means least, thank you to my parents for all of their love and support. I am eternally grateful.

## Summary

Previous research has shown that we recognise faces similar in age to ourselves better than older or younger faces (e.g. Anastasi & Rhodes, 2006). The primary aim of this thesis was to investigate this phenomenon in young adults and children to gain further insight into the underlying perceptual, cognitive and/or social mechanisms involved in this apparent “own-age bias” (OAB) in face recognition.

Chapter one confirmed that an OAB was present in both young adults and children, and the remaining chapters sought to address why this pattern may exist by drawing on the plethora of research into why a similar, potentially analogous bias occurs: the own-race bias (ORB). The ORB is the phenomenon that we are more accurate at recognising faces of our own race than those belonging to a different, less familiar race (see Meissner & Brigham, 2001 for review).

Perhaps the best known explanation of the ORB is the Contact Hypothesis. This suggests that the own-race memory advantage is due to the fact that people tend to have more experience with faces from their own race and, as a direct result, develop greater expertise at recognising them (e.g. Chiroro & Valentine, 1995). The second chapter sought to investigate whether a similar explanation could be applied to the OAB, and found supporting evidence for this claim.

The remaining studies examined what it is about contact with an age group that results in the superior recognition for faces of that age. By investigating perceptual expertise, social-categorisation and motivational explanations of the OAB, this thesis concluded that both quantity *and* quality of contact play an important role in the development of this bias. The findings of this thesis seem to be most consistent with a perceptual expertise account of the own-age bias in face recognition. However, it also seems likely that motivation to attend to faces (particularly with the goal of individuation) is likely to be a driving factor of this bias.

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## Chapter 1

### Introduction

Recognising people we know is a basic social act and as social animals, the need to identify increasingly large numbers of faces on a day-to-day basis makes face recognition the acme of perceptual classification skills. As adults we are highly expert at processing faces. We can readily identify facial expressions, establish a person's age, gender and race and, perhaps more astonishingly, distinguish between faces with reliability and ease, despite the high visual similarity within this particular class of stimuli. It is something that comes naturally to most of us, and it is something that we take for granted, however the question of *how* we develop this expertise for faces is one that is still not fully understood.

Previous studies that have examined expertise effects in face recognition have largely compared our ability to recognise faces and non-face objects (e.g. Diamond & Carey, 1986; Gauthier & Tarr, 1997; Gauthier & Tarr, 2002; Tanaka & Farah, 1993). However, this can only tell us a limited amount about how expertise may influence the way in which we process faces. As such, this thesis will examine the role of expertise in face recognition in a different context, investigating its role *within* the category of faces. Specifically, this thesis aims to establish whether expertise effects can offer an appropriate account of a phenomenon that has only recently begun to receive attention in the face recognition literature: the own-age bias, the finding that we are better at recognising faces belonging to our own age group compared to those of a different age (e.g. Anastasi & Rhodes, 2005; 2006).

## **1.1 Are Faces Special? Face Specificity versus the Expertise Hypothesis.**

One question that has dominated face processing research is whether the perception and recognition of faces can be distinguished from that of other visual objects. That is, do we treat faces as a special class of object using highly specialised qualitatively different cognitive mechanisms to process them? Or do we recognise them in the same way as other objects, but with quantitatively enhanced efficiency as a result of our expertise with faces?

### *1.1.1 Neuropsychological Evidence*

Case studies of individuals who have congenital or acquired damage to specific areas of the brain have provided evidence that the processing of faces and objects may be distinguishable at a neural level. For example, some patients have been reported to exhibit relatively intact facial recognition, but impaired recognition of everyday objects (Farah, 1991; McMullen, Fisk & Phillips, 2000; Moscovitch, Winocur, & Behrmann, 1997), while others have shown the opposite, displaying an apparently specific impairment to processing faces (Farah, 1991; Riddoch, Johnston, Bracewell, Boutsen & Humphreys, 2008). This face-blindness (prosopagnosia) is associated with damage to an area in the right (Uttner, Bliem & Danak, 2002) or, more commonly, bilateral (Delvenne, Braithwaite, Riddoch & Humphreys, 2002; Rossion, Caldara, Seghier, Schuller, Lazeyras & Mayer, 2003) occipito-temporal region, the fusiform gyrus.

Haxby, Hoffman and Gobbini (2000) interpreted this double dissociation as evidence that faces are processed in a different manner to other visual objects, using highly specialised anatomical substrates and cognitive mechanisms. However, this is not the only

possible interpretation. Instead, it could be that the regions of the brain that are damaged in prosopagnosics are responsible for more general types of processing that just happen to be essential in, but not specific to, the processing of faces. For example, it could be that the damaged areas are those required for expertly processing the fine-grained details of stimuli, which would be necessary for distinguishing between members of a group of objects which are highly visually similar.

Farah (1991; 1996) has specifically alluded to this idea, suggesting that it may not be a specialised face processing system *per se* that is damaged in prosopagnosia, rather it is an impairment of the ability to detect the subtle variations between highly similar exemplars of an homogenous class. As there are few other objects from homogeneous categories that we need to recognise at the exemplar level in the same way we do with faces (i.e. recognising the identity of an individual member of that class of stimuli), this deficit appears face specific as the damaged system is one that is “not necessary for (or less important for) recognising objects other than human faces” (Farah, 1996). The suggestion is that recognising and distinguishing between exemplars of a homogeneous class can only be successfully carried out once one has developed sufficient expertise with members of that group of objects. Specifically, Farah (1991) suggests that for expert face recognition to occur one needs to be able to successfully encode highly similar, complex visual stimuli in a configural/holistic manner. It is this processing system that she suggests is damaged in those who have prosopagnosia.

One of the arguments against the notion that prosopagnosia is the result of damage to a face-specific processing region is the fact that most prosopagnosics tend to also exhibit disturbances in their processing of other visual objects (Farah, Wilson, Drain, & Tanaka,



1995; Gauthier, Behrman & Tarr, 1999; McNeil and Warrington, 1993; Rossion et al, 2003). A complete dissociation between object and face recognition is, in fact, very rarely seen in prosopagnosia, although some researchers have reported incidences of deficits that appear to be restricted to faces only (Bukach, Bub, Gauthier & Tarr, 2006; DeRenzi & Pellegrino, 1998; Wada & Yamamoto, 2001). However all of the patients reported in these studies, whilst being able to successfully name pictures of visual objects, were not formally assessed for their recognition of individual exemplars belonging to non-face homogenous categories. Thus, it is probable that the tasks involved in these object recognition studies were not truly analogous to face recognition/processing.

Perhaps the most convincing evidence of a face specific deficit comes from Riddoch, Johnston, Bracewell, Boutsen and Humphreys (2008) who found that their prosopagnosic patient (F.B.) performed within the normal range for object naming, learning and recognition, even at the sub-ordinate level. However, while F.B. showed normal accuracy on all of the object tasks, reaction time data was not taken for all of them. This is a fundamental omission, as this allows for the possibility that “normal” performance for object tasks was achieved but at the expense of slow response times. To demonstrate an indisputable dissociation between face and object recognition, it is necessary to gain a full picture of F.B.’s performance, demonstrating both normal accuracy and response speed with object items from a homogenous class.

There is still an ongoing controversy as to how face-specific the visual processing deficits actually are in prosopagnosic patients. It is still relatively unclear whether the damage is to a truly face specific processing area or whether the deficits are a reflection of an impairment to successfully encode cues at a level of detail that is not required for most

other classes of objects. This debate is not restricted to prosopagnosia research, but is also accompanied by arguments regarding the specificity of the neural substrates involved in normal face processing, which are most commonly investigated using functional imaging techniques.

### *1.1.2. Functional Imaging Evidence*

Numerous studies have identified brain regions that respond more to faces than to other objects. The lateral fusiform gyrus has been dubbed the Fusiform Face Area (FFA) due to its relatively increased activation to facial stimuli in comparison to non-face objects (e.g. Henson, Goshen-Gottstein, Ganel, Otten, Quayle, & Rugg, 2003; Kanwisher, McDermott & Chun, 1997). The Occipital Face Area (OFA) also demonstrates face specific activation (Kanwisher & Yovel, 2006). At first sight one might take these findings to support the idea that faces are processed in a qualitatively different way to other objects. However, as with the issue of face specificity in prosopagnosia (see above), this is not the only interpretation of these observations.

Studies on the effects of expertise have been used to argue against the face specificity hypothesis. Generally we do not need to recognise everyday objects at the subordinate level, like we do with faces (i.e. recognising individual people). It is possible, therefore, that the brain regions identified above are not unique to face processing *per se*, but instead reflect our expert ability to perceptually distinguish between exemplars of a certain homogenous class of stimuli. As most people are experts with face recognition in a way that they are not with other forms of visual objects, this ability appears to be “special”. However, the *expertise hypothesis* (e.g. Carey, 1992; Diamond & Carey, 1986; Gauthier &

Tarr, 1997) suggests that this expertise with faces represents a potentially more general processing ability that could develop with any class of stimuli with which we have a large amount of experience at individuating exemplars.

If the FFA is truly face specific (and thus faces are a special type of visual form), then one would not expect to see any face-like activation of this region for non-face objects. If, however, face processing represents an expert ability to process objects belonging to a category with which we have a lot of experience (and therefore expertise), then one should be able to see face-like FFA activation for any objects of expertise. Gauthier and her colleagues investigated this idea by training individuals to become experts at differentiating novel objects with similar properties to faces (greebles). They found that greeble experts showed increased activation in the FFA when viewing greebles, similar to that seen when viewing faces, while novices did not show this pattern (Gauthier & Tarr, 2002; Gauthier et al, 1999). Similarly, Gauthier, Skudlarski, Gore, and Anderson (2000) demonstrated that car and bird experts showed enhanced FFA activation to objects belonging to their area of expertise (i.e. either cars or birds) compared to the control objects.

Gauthier and colleagues' findings from the functional imaging studies appear to support the expertise hypothesis of face recognition. However while it is important to understand how expertise may influence face and object recognition at the neural level, it is equally (if not more) important to understand how this might translate behaviourally. As such the observable psychological differences between face and object recognition need to be further explored.

### 1.1.3. Behavioural Evidence

Differences in the way we recognise faces and objects can be described anecdotally and seen every day. We are experts at distinguishing between faces (e.g. knowing Peter from Paul), however when it comes to identifying individual members of a non-face object category that belong to a similarly homogeneous group (e.g. differentiating between two Labradors) we perform markedly worse. However, there is one notable instance when this face-over-object recognition is considerably reduced (or absent): when faces are presented upside-down.

It is well documented in the face processing literature that the recognition of faces is dramatically impaired by inversion (cf. Maurer, Le Grand, & Mondloch 2002; Rossion & Gauthier, 2002; Valentine, 1988 for reviews). In his seminal paper in 1969, Yin observed that rotating visual stimuli by 180 degrees disproportionately affected the recognition of faces compared to other mono-oriented objects. This *inversion effect* has been successfully replicated in dozens of studies using traditional recognition memory paradigms (e.g. Carey, Diamond, & Woods, 1980; Philips & Rawles, 1979) and in alternative forced choice (AFC) paradigms (e.g. Carey & Diamond, 1977; Diamond & Carey, 1986; Freire, Lee, & Symons, 2000; Leder & Bruce, 2000; Tanaka & Farah, 1993; Valentine & Bruce, 1986; Yarmey, 1971; Yin, 1969) and is present for both familiar and unfamiliar faces (Collishaw & Hole, 2000; Yarmey, 1971). The robustness of this effect may be taken as evidence that faces are processed in a special manner, and indeed Yin suggested that his findings were indicative of a specific mechanism for the processing of faces compared to other visual stimuli. However, reviews by Valentine (1988) and Tovée (1998) found little evidence to implicate a unique face-processing mechanism, an issue that is one of heated ongoing debate in the

literature. For an example of this, see the communications between Robbins and McKone (Robbins and McKone, 2007; McKone and Robbins, 2007) and Gauthier (e.g. Gauthier and Bukach, 2007).

In fact, one particularly influential study suggested that this inversion effect may just reflect the expertise with which we process faces compared to other objects. Diamond and Carey (1986) showed that the putative face-specific inversion effect could be obtained with mono-oriented non-face stimuli when one had extensive experience at discriminating between exemplars belonging to that class of non-face object. They found that dog experts showed a face-like inversion deficit for pictures of dogs, while novices did not. More recently Bruyer and Crispeels (1992) have demonstrated similar expert inversion effects using handwriting as stimuli. In addition, Rossion et al (2002) trained participants to become experts at differentiating greebles. They showed that reaction times to Greebles were more impaired by inversion following training than before, although there was no effect on accuracy. While this research appears to support the aforementioned expertise hypothesis, it is of note that similar research with car (Xu, Liu & Kanwisher, 2005), bird (Gauthier et al, 2000) and Labrador (Robbins and McKone, 2007) experts has not yielded significant inversion effects with objects of expertise, although it is possible that the participants used in these studies were not sufficiently expert with the classes of stimuli used. It is also possible that task confounds may be responsible for the differences in these findings. In contrast to Diamond and Carey (1986) and Bruyer and Crispeels (1992), neither Xu et al (2005) nor Gauthier et al (2000) used a traditional memory paradigm in their investigations, opting for sequential matching tasks instead. However, it is important to note that in all of the previously described studies (with the exception of Diamond &

Carey, 1986) the inversion effects obtained with experts were very small in comparison to the typical inversion effect obtained with faces.

In summary, it seems that faces are always, with Diamond and Carey's (1986) contradictory results being an anomaly, disproportionately affected by inversion, compared to other non-face objects. However there does appear to be some evidence of non-face objects of expertise showing a similar pattern under specific circumstances. These findings lend support to the idea that expertise with faces plays a key role in the way in which they are processed compared to other objects.

#### *1.1.4. Conclusions*

The question of face specificity is one that has been debated heavily over the last few decades. However, it is not the purpose of this thesis to try and resolve this argument. The work of Isobel Gauthier and her colleagues has presented some compelling evidence that expertise may play an important role in the processing of facial stimuli. However this work has been restricted to looking only at faces versus non-face objects. This thesis seeks to further explore the role that expertise plays in face recognition, within the domain of face processing itself. That is to say, while we are experts at recognising faces, are there certain groups of faces with which we are more expert than others and does this have implications for the cognitive and neural mechanisms used to process them?

## **1.2. Expertise and Face Processing: The Role of Configural Processing in Face Recognition.**

### *1.2.1. What Information do we Process in the Face?*

Faces are essentially extremely similar to one another and all share the same first-order relational features (i.e. they all have the same basic arrangement of features: two eyes, above a nose, above a mouth). To successfully recognise a face we need to be able to identify the ways in which individual faces differ from each other. For this purpose, there are two types of facial information which we can rely on (see Figure 1.1.). The first type of information contained in the face is that of the individual components themselves; processing information about each of the facial features as a distinct part. The second type pertains to the second order relational information contained in the face (Diamond & Carey, 1986). This refers specifically to information about the spatial relationships between key features of the face (configural or holistic information<sup>1</sup>).

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<sup>1</sup> Configural and holistic processing, while similar concepts, are referred to in the face processing literature as two distinct ideas. Mondloch, Le Grand & Maurer (2002) define holistic processing as the 'glueing' together of the features such that information about individual features is less accessible. In contrast, configural processing refers specifically to the idea that we encode the second-order relations contained within the face (i.e. the spatial relationships between the individual facial components; Diamond & Carey, 1986) in contrast to the more featural/component processes which rely heavily on information about the isolated facial features.

*Featural Information**Configural Information*

**Figure 1.1. Examples of the type of information present in the face**

When asked to describe a face, anecdotally we tend to think in terms of individual features (e.g. big blue eyes, pouty lips, pointy nose) which is probably at least partly due to the fact that we have accessible vocabulary for describing individual facial features in this way. Trying to describe a face in a way other than breaking it down into its constituent parts is far more difficult. However while we might more easily describe a face in terms of its individual features, it seems unlikely that our perceptual system would represent faces simply as a list of features. Instead there is a wealth of evidence that suggests that in face processing, the whole is equal to more than the sum of its parts (e.g. Tanaka & Farah, 1993). That is to say that the more holistic, or configural spatial relationships between the features may play a more important role in face processing than the information about the individual facial features themselves.



One paradigm that was specifically designed to measure the interdependence of the featural and configural information in the face is that of the part-whole face paradigm (Tanaka and Farah, 1993). Tanaka and Farah (1993) asked participants to learn a series of faces or houses that were presented either upright, inverted or scrambled. Participants were then asked to recognise target features belonging to the previously presented faces (e.g. a nose) or houses (e.g. a door) that were presented either in isolation, or within the whole face or house. The key finding was that participants were better at recognising the features from upright intact faces when they were presented within the whole face compared to when they were presented individually, demonstrating the importance of showing the features within the context of the face. In contrast, for non-face objects (i.e. houses, scrambled and inverted faces), no advantage of presenting the target features in their context was found. This finding lends its support to the notion that while object recognition relies heavily on part-based, featural representations, faces are processed in a more holistic fashion.

Further evidence for the importance of configural/holistic information in the processing of faces can be seen from the composite face effect (e.g. Young, Hellawell & Hay, 1987; Hole, 1994). This is the effect experienced when faces are divided into upper and lower halves and the top half of one person's face is then presented with the bottom half of someone else's face. When the two halves are shown upside-down or misaligned, participants are quite accurate at identifying the top half of the face. However, when the two halves are aligned and joined to produce a new face configuration, participants find it very hard to identify either half of the face. These findings demonstrate that the ability to successfully extract identifying information from the individual facial features is overridden

by the presence of the new facial configuration. This supports the idea that configural information is more important than featural information in face recognition.

#### *1.2.2. Effects of Inversion on Configural Processing*

One thing that has become evident through face recognition research is the fact that adults rely heavily on the configural information contained in the face (see above). In fact, the robust inversion effect (described in section 1.1.3.) is thought to be the result of a disruption to the configural cues contained in the face. One source of evidence that suggests this might be the case comes from the Thatcher Illusion (Thompson, 1980). In this illusion the eyes and the mouth within a pictured face are rotated at 180 degrees relative to the rest of the face, resulting in a grotesque distortion which is easily detected when the face is presented upright. However, if that same face is viewed upside-down, the perceived degree of distortion no longer appears so great and is sometimes barely detectable (see Figure 1.2. for an example of this effect).



**Figure 1.2 Illustration of the Thatcher Illusion**

The Thatcher Illusion illustrates our insensitivity to configural information in inverted faces, in this case as demonstrated by our difficulty in detecting a mismatch between the orientation of the face and its component features. Without the ability to use the configural cues in the inverted face, we are unable to recognise the bizarre relationship between the different facial features, which makes the perceived grotesqueness of the Thatcherised faces all but disappear. Searcy and Bartlett (1996) demonstrated the importance of configural information (and the lack of importance of featural information) in this illusion by asking participants to rate the grotesqueness of faces that had been subjected to either the typical Thatcher-esque spatial alterations or that had had grotesque changes made to the individual facial components themselves (e.g. blacking out teeth). The authors found that while participants showed the typical Thatcher Illusion for spatially

altered faces (i.e. they rated faces as more grotesque when they were upright, compared to when they were inverted), faces with featural alterations were rated as similarly grotesque in both orientations. In addition, they concluded that as this effect is a perceptual illusion and does not involve memory in any way, it provides evidence that the disruption of the configural processing occurs at the encoding, rather than retention, level.

Further evidence that inverting the face disrupts the configural, but not the featural, information in the face comes from work that has examined our ability to detect subtle changes made to either the spatial or featural information of faces presented either upright or upside-down. For example Leder and Bruce (1998) showed that relational changes to the distances between facial features were better detected when faces were presented upright compared to inverted. When, however, the changes that were made maintained the spatial relationships, but altered the individual features (i.e. replacing one feature with that from another face), no effect of inversion was found. Similarly, Freire et al (2000) asked participants to discriminate faces that differed either in terms of the shape of individual features, or the spatial relationships between them and found that inversion only significantly reduced their accuracy when attempting to detect the spatial changes.

An additional finding that suggests that inversion disrupts our configural processing comes from the observation that the composite face effect disappears when faces are inverted (e.g. Young et al, 1987). In fact, participants actually become better at identifying the face halves when the composites are presented upside-down. Given that our recognition ability is poorer when faces are inverted this result may seem strange, however it can be explained in terms of the facial information that we use to identify the face. If we rely more heavily on configural information, then aligning two halves of two separate faces

will result in the apparent creation of an entirely new facial identity. The presence of this new configural information interferes with our ability to extract the featural information from the face, making it difficult to identify the original face halves. If however, we utilise more featural/piecemeal cues we can identify the face from its features; and this is what we see when the faces are inverted. By inverting the face it appears that we are reducing our reliance on configural processing<sup>2</sup>, giving rise to more featural processing, allowing us to see the constituent identities.

### **1.3 The Role of Familiarity in Face Recognition**

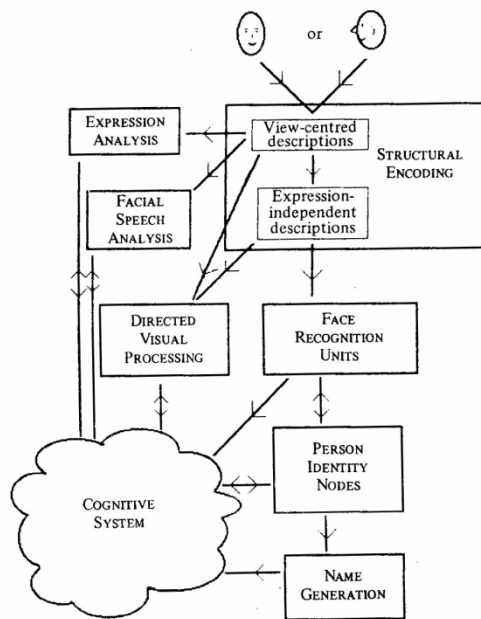
One issue that one comes up against when asking how we recognise faces is the fact that a plethora of research has suggested that not all faces are treated in the same way. One important factor seems to be how familiar we are with the face(s) being recognised. Anecdotally we know that recognising the face of someone we know well is easier than recognising the face of someone with whom we have had little experience. Bruce (1982) demonstrated that we are generally very good at quickly and accurately recognising the face of somebody we know, despite the potentially huge variations in factors such as viewpoint, illumination of the face and facial expression. In contrast, our ability to recognise, or even match, unfamiliar faces is fairly poor (e.g. Burton, Bruce & Hancock,

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<sup>2</sup> NB – there is also evidence that featural processing plays an important role in expert face processing and that inversion disrupts this information to some extent (e.g. Mondloch, Le Grand & Maurer et al, 2002; Rhodes, Hayward & Winkler, 2006). However as inversion appears to disrupt featural processing much less than configural processing (e.g. Collishaw & Hole, 2000), this thesis will concentrate on the role of configural processing in expert face processing. Although it is worth acknowledging at this point that the inversion effect is likely to be the result of impaired encoding of both the configural and featural cues contained in the face.

1999; Bruce, Henderson, Newman, & Burton, 2001; Yarmey, 1979). These differences suggest that we may process familiar and unfamiliar faces in a different manner.

In order to try and shed some light on this issue, a number of face processing models have been developed which have tried to account for how faces of different familiarity may be processed. Perhaps the most influential of these models is that proposed by Bruce and Young (1986), which is illustrated in Figure 1.3. below.



**Figure 1.3 Bruce and Young's (1986) functional model of familiar face recognition.**

In this model Bruce and Young (1986) emphasise that our experience with faces plays an important role in face recognition by suggesting that familiar and unfamiliar faces are processed in qualitatively different ways. They suggest that familiar face recognition essentially takes place through a process of successfully matching the structural information that is encoded upon seeing a face with a stored representation of that face in the “Face Recognition Units” (FRUs; the processing component that contains information

about all of the faces one knows). If matching occurs, the appropriate FRU automatically fires, sending a signal to the “Person Identity Nodes” (PINs) which then allows semantic information about individuals to be accessed. Through these nodes, name generation can be accessed. In contrast, unfamiliar faces are processed from the early structural representations via directed visual processing. This allows a temporary visual representation of the face to be built up, and it is this processing module that is thought to be responsible for mediating simple face judgments and recognition of unfamiliar faces (Campbell, Brooks, deHaan & Roberts, 1996).

Evidence that supports the notion that familiar and unfamiliar faces are processed using qualitatively different cognitive strategies can be found in the experimental psychology literature. For example, Ellis, Shepherd and Davis (1979) tried to address the issue of exactly what it is about a face that gives way to recognition (of both familiar and unfamiliar faces), by investigating which facial features/properties are important to these processes. In two experiments the authors presented participants with photographs of either familiar (famous) or unfamiliar faces which they were asked to remember. Using a standard recognition memory paradigm, participants were then asked to identify the faces that they had seen before from a selection of photographs which were presented either in whole, or in part (either showing only the internal facial features or the external facial features). Ellis et al found that recognition accuracy rates of famous faces were higher when internal features were presented in isolation compared to when only external features were presented. This ‘internal advantage’ was not present for the unfamiliar faces.

In a similar study, although using a face-matching paradigm, Young, Hay, McWeeny, Flude and Ellis (1985) also found evidence that the internal features of the face

are of relatively greater importance for the processing of familiar faces than unfamiliar faces, a pattern which has been replicated by Bonner, Burton, and Bruce (2003). These findings support the notion that familiar and unfamiliar faces are processed in qualitatively different ways, and suggest that recognition of faces of higher familiarity relies more heavily on the configurally rich internal features of the face than the external features.

Additionally, neuropsychological studies have provided evidence that we process familiar and unfamiliar faces differently. For example, Warrington and James (1967) reported a patient who was specifically unable to recognise familiar faces (prosopagnosia), but who was still able to successfully match photographs of unfamiliar faces. The opposite pattern has also been observed. Benton (1980) described a patient who was unable to match unfamiliar faces, but was able to recognise the faces of familiar people. This double dissociation appears to indicate that familiar faces are processed in a qualitatively different way to unfamiliar faces, using different mechanisms, a claim that is also supported by studies implicating the involvement of different regions of the brain for processing these different classes of facial stimuli (George et al, 1999; Wiser et al, 2000). Thus, the role of familiarity in face recognition is one that has important implications for how we process and recognise faces.

However, while it is clear that familiarity plays an important role in face recognition, whether the difference between processing familiar and unfamiliar faces is truly a qualitative one has not gone unquestioned. Firstly, while internal features are found to be of relatively greater importance in the processing familiar faces, that is not to say that they are of no importance in unfamiliar faces. It may just be that as external features (e.g. hair, face shape etc) are more changeable, they are less likely to be useful cues to rely on



for the recognition of someone who one has known for a long period of time, and thus reliance on these cues quantitatively decreases accordingly; whilst the reliance on internal cues, in turn, increases. In regard to the neuropsychological evidence, research in this area often confounds the familiarity of the stimuli with the nature of the task (i.e. face matching for unfamiliar faces versus recognition paradigms for familiar faces). As such, it is unclear whether a true double dissociation between the processing of familiar and unfamiliar faces can really be claimed.

However, these criticisms do not belittle the influence that familiarity has on face recognition. Instead, it has been suggested that the difference between processing faces of different familiarity is a quantitative, not a qualitative one. For example, Rhodes (1985) and Burton, Jenkins, Hancock and White (2005) suggest that the processes involved in recognising familiar and unfamiliar faces are essentially the same (i.e. the facial images are all mapped onto memory representations), they just take place at different points on a continuum that varies with regard to the strength of the memory trace (and other associated codes). If a face is unfamiliar, these authors argue that a representation (albeit a relatively rudimentary one) will be formed on first sight, which will be capable of giving rise to recognition in subsequent viewings. This memory representation becomes more robust with subsequent exposures to the face, making the face more familiar and easier to recognise.

Regardless of whether the difference that familiarity makes in face recognition is a qualitative or a quantitative one, it clearly plays an important role in the processing of individual faces. One question that this thesis seeks to address is whether the influence that familiarity has on face processing can be extended from the realm of individual faces, to a

more general influence on groups of faces. For example, there are some groups of faces with which we have more experience (and hence are more familiar with) than others; the question is, does this extra experience have any implications for the way in which we process those faces in comparison to faces belonging to other, less familiar groups?

#### **1.4. The Practical Implications Associated with the Recognition of Faces of Differing Familiarity.**

The ability to successfully recognise faces that we have seen before is extremely important in everyday life and research into this area is of great theoretical, personal and practical importance. The understanding of how we encode visual information from the face and how we are later able to recall/recognise this information lays the foundations for the development of theories of face perception (and also informs our knowledge about visual perception as a whole). The significant role that face recognition plays in terms of the more personal and practical domains is perhaps best illustrated using examples of instances where face recognition fails. While there is the obvious embarrassment that is associated with the social *faux pas* of not recognising someone that you have met several times before (i.e. a familiar face), the consequences associated with this kind of error when the target face is relatively unfamiliar can be significantly more devastating when considered in terms of eyewitness identification.

Eyewitness testimony is often the most persuasive evidence given in a court case, and it has the power to lead to the conviction (or exoneration) of the accused. Previous

research has shown that jurors believe witness statements about 70% of the time (Lindsay, Wells & O'Connor, 1989; Loftus, 1983). Unfortunately though, further evidence has shown that while eyewitness testimony is highly influential, jurors are unable to tell whether the testimony given is accurate or not; accurate eyewitnesses are believed about 68% of the time, in comparison to 70% for inaccurate witnesses (Lindsay, Wells & O'Connor, 1989). If eyewitnesses were 100% accurate in their memory for an event, then this issue would not present a problem, however previous research has shown that we are notoriously inaccurate when trying to recall/recognise the face of someone we have only seen once before (i.e. an unfamiliar face).

In order to further understand how reliable eyewitness identifications are, and to gain further insight into the real-world implications of this, a number of studies have investigated the actual outcomes of lineup identifications by witnesses in the UK. Valentine, Pickering and Darling (2003) investigated the outcome of 640 eyewitnesses' attempts to identify suspects implicated in serious crimes from 302 live lineups. They were particularly concerned with establishing which factors were likely to predict an increased likelihood of positively identifying a suspect from a lineup. The factors they investigated were those that a jury has to be legally informed about according to the "Turnbull guidelines" (*R v Turnbull and others*, 1976). In England, a judge presiding over a case where the outcome is substantially dependent on eyewitness evidence is legally obliged to notify the jury of the inherently unreliable nature of identification evidence and the need for caution when considering this evidence. In particular, they are obliged to instruct a jury to carefully consider the following factors when deliberating: the amount of time for which the witness viewed the suspect, the distance between them, the conditions of visibility,

whether the witness knew the suspect, if there were any reasons for the witness to remember the suspect, the time lapse between seeing the suspect and identifying them and whether there were any discrepancies in the descriptions given by witnesses.

As a result of their enquiry, Valentine, Pickering and Darling (2003) found that only two of the above-mentioned factors had a significant effect in predicting whether a witness positively identified a suspect: whether or not the suspect was familiar to the witness and for how long the witness saw the suspect (which is arguably also a measure of familiarity). The effect that familiarity has on eyewitness identifications is evidenced by their findings that when the suspect was known to the witness, 73% of witnesses picked the suspect from the lineup, 5% picked a foil<sup>3</sup> while the others made no identifications. In contrast, when the suspect was unknown to the witness, only 41% of the witnesses identified the suspect, and 21% misidentified a filler. This latter finding is consistent with the findings of two studies that also investigated the outcomes of real lineup identifications in the UK. In their survey of 616 lineups in Greater London (including 1561 witnesses), Wright and McDaid (1996) found that 39% of their witnesses identified the suspect, while 20% identified a filler. Similarly, in an even earlier study, Slater (1994) found that eyewitnesses picked the suspect 36% of the time, while 22% picked somebody else from the lineup.

What is evident from these studies is that witnesses erroneously choose someone known to be innocent around 20% of the time (i.e. they choose fillers). However, this

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<sup>3</sup> A lineup is a police procedure whereby witnesses to a crime view the person that the police suspect committed the crime in amongst a number of members of the public. The innocent parties are known as foils, fillers and distracters in the forensic psychology literature. The witness is then asked to identify the perpetrator from the lineup, after being informed that they may or may not be present.

number may well be an underestimate. This is due to the fact that the person the police suspect of committing a crime is not always the perpetrator. In fact the main purpose of a lineup procedure and eyewitness identification is to gather evidence to ascertain whether or not the suspect is likely to be the culprit. This suggests that out of the 40% of witnesses who positively identify a suspect, at least some of them are likely to have made an erroneous identification. In fact, through a review of the existing research in eyewitness identification, Penrod (2003) estimated that when a suspect is identified as the culprit by the witness, the suspect will be innocent 14% of the time. This is a disturbing statistic, with even more disturbing potential real-world consequences.

The misidentification of a police suspect as the perpetrator of a crime can lead, and has led, to the false imprisonment of an innocent person. Knowing the extent of these miscarriages of justice has only recently been made possible, predominantly through the advancements in DNA research, which was first introduced into the forensic arena in 1986. The development of DNA testing gives those who have been incarcerated for a crime that they did not commit a chance of proving their innocence if appropriate samples were collected in the original investigation. Such is the power of DNA evidence, several organisations around the world have been set up with the sole aim of exonerating wrongly convicted people through DNA testing.

Perhaps one of the most influential organisations is that of The Innocence Project, which is run by the Benjamin N. Cardozo School of Law, based in America. Since its inception in 1992, The Innocence Project has overturned 238 convictions (as of 09/05/09). The average length of time served by those who were exonerated is 12 years, with 17 of those innocent people serving time on death row. And most worrying is the fact that the

leading cause for these wrongful convictions, accounting for 77% of the cases, was eyewitness misidentification. This finding has been supported by studies in the forensic psychology literature which have reviewed a number of cases that have been overturned due to subsequent contrary DNA evidence. For example, of the sixty-two cases that were investigated in two studies, fifty-two of them (85%) involved mistaken eyewitness identification as a leading cause of conviction (Conners, Lundregan, Miller & McEwen, 1996; Scheck, Neufeld, & Dwyer, 2000). It is for this reason alone that understanding the circumstances under which a witness is likely to be reliable (or not) is of the utmost importance.

This section has examined the real world impact that familiarity can have on eyewitness identification and, as the face is the most important key to person's identity, face recognition accuracy. As stated at the end of Section 1.3., this thesis seeks to investigate whether this influence of familiarity extends beyond that of increasing the accuracy with which we recognise individual faces. While we are more likely to positively identify the face of someone we are more familiar with, than of someone we are not, does this familiarity effect have a more general influence on face recognition? For example, are there some groups of faces which we are likely to be better at recognising than others? If familiarity plays a more general role in face recognition then we would expect this to be the case, as there are some groups of faces with which we have more experience than others (for example, we tend to be more familiar with faces from our own demographic, as we tend to spend more time with people of our own age, race etc).

If we are better at recognising people from our own age group, then this could have several implications for how reliable an eyewitness is likely to be in court and how much

weight should therefore be given to an individual's testimony. Given that the British Crime Survey for 2001 revealed that the majority of persons accused of a crime (cautioned, charged or summoned 1999-2000) by the Metropolitan Police force are males aged between 16-24 years of age (Bolling, Clemens, Phelps & Smith, 2002), it might be that young adults (who are more familiar with people of this age group) are more likely to be accurate eyewitnesses than people belonging to a different age group. It is this notion that will be further discussed and analysed throughout this thesis. And it is one that certainly merits further investigation.

In their study investigating the effects of various factors on the likelihood of a witness positively identifying a suspect from a lineup, Valentine et al (2003) noted that in their London-based sample, the accuracy of the witness significantly decreased with age. That is, while 48% of witnesses under 20 and 45.7% of witness between 21-30 years of age (the age brackets containing the most common age band of offenders in the Metropolitan area) positively identified the suspect from a lineup, this was only the case for 35.6% of 31-40 years olds and 27.9% of those over 40. Interestingly though, age did not have a significant effect on the likelihood of the witness identifying a foil. While this may be a bit of a theoretical leap at this stage, these findings suggest that increased familiarity with an age group may give rise to better recognition of faces belonging to that age group (even though the faces are individually personally unfamiliar). However at this juncture it is difficult to make these claims without knowing the exact ages of the suspects/foils included in this study. It is also impossible to rule out the fact that the decreasing accuracy with age might just be a product of the ageing process itself, and nothing to do with the age of the suspects.

Before further discussion of this effect takes place, it is first important to ascertain 1.) whether it is likely that faces belonging to different age groups might be processed in a distinct manner (that is, whether faces of differing ages are sufficiently different from one another to be treated in different ways by our perceptual system) and 2.) how our ability to recognise faces changes with age.

### **1.5 Are Faces of Different Ages Physiognomically and Perceptually Distinct?**

In order to ascertain whether it is likely that faces belonging to different age groups may be processed in differing ways, it is first necessary to determine whether the variation between faces of different age groups is sufficient enough to allow them to be treated as separate by our perceptual system. Unless there are noticeable physiognomic facial changes with age, it is unlikely that we would process faces of different age groups differently, making it very unlikely that familiarity effects would be possible with faces of different age groups.

#### *1.5.1 The Ageing Face*

While there has been a substantial body of research into how we recognise faces and other face processing abilities, comparatively little attention has been given to age perception and the role that facial age may play in face recognition. For example, existing models of familiar face recognition have largely failed to include consideration of how face-processing systems manage to recognise a face as being familiar despite age-induced changes (e.g. Bruce and Young, 1986; Burton, Bruce and Johnston, 1990). As George and



Hole (1998) point out, this is a major omission in our understanding of the processes underlying face perception. The issue of how our visual system manages to recognise faces despite age related changes is one instance of a more general issue that researchers in this field face. That is, how do we establish a match between a face that we see and an internal stored representation of that face, considering all of the changes that take place between one encounter with the face and the next (e.g. light, position, expression, age, etc)? Familiar face recognition is not the only domain in which the role of facial age has gone relatively unexplored. Research into unfamiliar face processing has also failed to give due attention to the process of facial ageing.

This omission in the face processing literature is surprising, especially given the importance of age as a facial characteristic: Shepard, Davis and Ellis (1981) identified age as one of only three major dimensions that seem to account for all perceived variation between faces (along with hair and face shape). And why shouldn't age be important? After all, the facial changes brought about by ageing are by no means subtle. From when we are born all the way through to old age our faces are constantly changing in a number of ways. Our facial appearance is determined by both the underlying shape and growth of our skull, and also by muscular tone, the distribution of fatty tissue and the texture and pigmentation of our skin, all of which are factors that change with age.

From birth through to adulthood some substantial structural and textural changes to the shape of the face and skull take place (review in Enlow, 1982). As infants we have smooth skin, small noses and relatively large eyes, set lower down in the face. Throughout childhood and into adolescence our cranio-facial shape is subject to considerable alteration due to a cardiodial strain transformation, which results in seemingly longer facial features

(especially as our nose and nasal bridge grows), a more defined face shape (particularly the chin and jaw line) and a reduced forehead. Beyond adolescence and throughout adulthood our hair starts to grey and thin out, nose and ears continue to grow and our bones thin.

Like all organs, our skin is also subject to the degenerative process of ageing. Levels of elastin decrease with age, and without it skin loses elasticity resulting in changes to our skin texture. Dermal tissue atrophies as part of the ageing process and decreases by approximately 20% in older people and the collagen content of the dermis decreases by about 1% per year throughout adult life (Rigel, Weiss, Lim & Dover, 2004). These biological changes to the facial soft tissue, coupled with the repeated traction exerted by our facial muscles over expression lines, produce increased wrinkling as we progress through adulthood. In addition, the collaborative effects of the reduction (and redistribution) of subcutaneous facial fat and the persistent gravitational forces we are subjected to throughout our lifetime combine to produce sagging, loose skin (Nigam and Knight, 2008). In short, we look very different at various points throughout our life.

One study that has provided evidence of how the facial changes brought about by age can substantially alter our appearance is that of Bruck, Cavanagh and Ceci (1991). In their face recognition study, participants were asked to match high-school photographs with pictures of the same people 25 years later. Participants were either former classmates of the people depicted in the photographs, or they were complete strangers (controls). While those who had prior familiarity with the faces performed more accurately than the controls, their performance was far from perfect, achieving a mean of only 49% accuracy (compared to 33% for the controls; chance performance was 10%). Despite performance being above chance, this performance is still pretty poor, especially considering that some of the

participants had once been personally familiar with the photographed subjects. In addition, these accuracy rates are considerably lower than those usually seen in either familiar or unfamiliar face matching tasks when there are no age differences between the photographs of the targets, where we normally achieve around 90% and 70% accuracy respectively (e.g. Bruce et al, 1999; Bruce, Henderson, Newman & Burton, 2001). As such, this study illustrates that even when we have been personally familiar with a face, the changes brought about by ageing make it difficult for us to recognise them.

### *1.5.2 The Perception of Facial Age*

As the previous section discussed, our face can look very different at different points throughout our life. The changes brought about by ageing are varied and plenty. However one question that has not yet been addressed is whether we are successfully able to extract age information from a face allowing us to accurately estimate a person's age. To this end a number of studies have asked participants to view facial photographs belonging to different age bands and estimate their ages. For example a couple of recent studies by George and Hole (2000) and Sörqvist and Eriksson (2007) have demonstrated that that we are fairly accurate at perceiving facial age, with estimated age only deviating from actual age by a magnitude of about 3-4 years. These studies are in line with those that have illustrated our ability to estimate the age of photographic stimuli to within a few years of the actual ages of individuals (Burt & Perrett, 1995; George & Hole, 1998; Pittenger & Shaw, 1975).

However, there is evidence that some groups of people are better able to accurately estimate facial age than others. For example, Dehon and Bredart (2001) showed black and

white participants photos of individuals belonging to both racial groups, aged between 20-45 years old. They found that while black participants were equally accurate at assessing the ages of both groups of photographs, white participants performed significantly more accurately with own-race faces. The authors concluded that this asymmetrical own-race advantage for age perception may have been the result of the fact that the participants had lived in a majority Caucasian population for at least 5 years. Thus higher inter-racial experience had eliminated such a perceptual advantage for the black participants.

It appears that there may be an experience-based own-group age perception advantage, at least in terms of race. Another dimension along which age estimates have been found to vary is in terms of the age of the perceiver themselves. For example, some studies have shown that participants are more accurate at estimating the age of facial photographs when the faces belong to the same age bands as themselves (Anastasi & Rhodes, 2006; George & Hole, 1995). This own-age age estimation advantage has also been found with children as young as 6 years old (George, Hole & Scaife, 2000). Using a slightly different procedure than that usually used for assessing age estimation accuracy, the authors showed children pairs of facial stimuli, aged between 1-80 years old, and asked them to identify which was the oldest face. They found that children performed significantly more accurately when both photographs were of child age (the cohort which they are arguably most familiar with). It is of note, however, that while these studies have found evidence of an own-age age perception advantage, a study investigating the ability of participants to estimate the ages of facial stimuli spanning 35 years and in seven distinct age groups showed no such effect (Burt & Perret, 1995).

In summary, research has shown that we are able to estimate facial age to a high degree of accuracy. In addition, there is some evidence that we may be better at this age estimation when the faces we are perceiving belong to the same in-group as us (e.g. they are of the same race, age group etcetera). Although given the dearth of research that has been carried out in this area, further work may be necessary to establish whether this is truly the case.

## **1.6 Becoming a Face Expert: The Development of Face Recognition**

### *1.6.1. Face Recognition Accuracy from Birth to Adulthood.*

As adults we are experts at processing faces. From viewing a single face we can quickly and efficiently gain a plethora of information; we can tell someone's age, gender and race, gauge someone's mood from their expression, read their lips, follow their gaze and, perhaps most impressively, identify who they are. However the question of how we develop this expertise is still the subject of some debate. From as early as 9 minutes after birth we do appear to show some rudimentary face processing skills (e.g. Goren, Sarty & Wu, 1979). Newborns attend more to face-like stimuli than non-face patterns (Goren et al, 1979; Johnson, Dziurawiec, Ellis & Morton, 1991; Mondloch et al, 1999; Valenza, Simion, Cassia, & Umiltà, 1996) suggesting that we may be born with a reflex-like sub-cortical mechanism that encourages infants to direct their attention towards faces immediately after birth (Johnson and Morton, 1991). Johnson and Morton proposed that this mechanism (termed *conspec*) is effective during the first two months of life and contains an innate representation of the human face that essentially comprises information about the first-

order spatial arrangement of the main facial features (e.g. two eyes above the nose, which is above the mouth). The main function of conspec is hypothesised to be to ensure infants orient to toward face-like patterns, so that the correct input is provided for the rapidly developing cortical circuitry, and it is this that may well lay the foundation for our expert face processing abilities in adulthood. This theory suggests that the information contained in the face about the spatial relationships between the constituent features are important from the moment we are born.

In addition to orienting towards faces, neonates have also been seen to exhibit more complex face recognition abilities. Visual preference and habituation techniques have been used to show that neonates, averaging between 12 and 78 hours old, are able to discriminate their mother's face from a stranger's (Bushnell, 2001; Bushnell, Sai & Mullen, 1989; Field, Cohen, Garcia & Greenberg, 1984; Pascalis, Schonen, Morton, Deruelle, & Fabre-Grenet, 1995; Walton, Bower & Bower, 1992). Not only did infants prefer to look at their mothers in visual preference tasks, but after repeated exposure, habituation to their mother's face occurred, followed by a renewal of interest when the stranger's face was presented. This illustrates that even very young infants are able to discriminate between faces, and preference for their mother's face suggests that despite extremely limited exposure, infants can recognise at least some aspect of their mother's face.

So it would appear that within moments of being born we are able to demonstrate at least some evidence of face processing and recognition skills. Obviously this does not necessarily mean that neonates process information about faces in the same way as adults do, but it does seem that newborns come into the world with some rudimentary face processing mechanisms. However, young children are not as proficient as adults at

processing faces, particularly with regard to face recognition. Even when memory demands are eliminated (for example, when using face matching tasks rather than traditional memory paradigms to measure facial recognition ability), children still perform worse than adults (see Bruce et al, 2000).

Over the last 40 years, a number of studies have sought to track the development of face recognition abilities in children. Using either two alternative forced-choice (e.g. Carey & Diamond, 1977; Carey, Diamond & Woods, 1980; Goldstein & Chance, 1964; 1965) or old/new recognition paradigms (e.g. Ellis & Flin, 1990) face identification accuracy has been shown to increase steadily between the ages of 6 years old and 9-10 years old. Beyond age ten, face recognition abilities continue to improve into adolescence and following a slight dip around age twelve, reaches asymptote in the mid-to-late teens (e.g. Carey et al, 1980; Flin, 1980; 1983; George, Hole & Scaife, 2000).

While studies using traditional research methodologies have suggested that children's face recognition abilities are relatively poor, research from the more forensic spheres has produced very different results. For example, in their meta-analysis of studies employing either target present or target absent line-ups to assess face recognition, Pozzulo and Lindsay (1998) found that by 5-6 years of age children were able to correctly identify a target with adult-like accuracy. This is possibly due to the fact that task demands in these types of study are considerably less than those involved in more traditional recognition memory paradigms, where participants are typically asked to recognise a relatively large number of photographic facial stimuli. However, while this study appears to suggest that children's face recognition abilities may have been underestimated by the more lab-based

studies, it is of note that all age groups of children (between 4-13 years of age) performed worse than adults with target-absent line-ups, misidentifying significantly more foils.

In addition, at least one study using a traditional memory paradigm has found evidence that previous work may have underestimated children's face recognition abilities. In a study by Feinman and Entwisle (1976) it was found that children reached adult levels of identification accuracy by the age of 11 years old. One potential reason for this finding may be due to the nature of the stimuli that were used in this study. While most recognition studies present participants with faces of adults, this study used children's faces. The suggestion is that children may find the recognition of own-age faces easier than that of adult faces, possibly as a result of the fact that they have more experience with (and therefore more knowledge of) faces belonging to their own age group. This idea is supported by the finding that children perform in a more adult-like fashion in face processing studies when the facial stimuli are similar in age to themselves (e.g. George, Hole & Scaife, 2000). In addition, it is possible that adults are less familiar with children's faces and are therefore slightly impaired in their performance. This idea is certainly supported by the finding that adults are less accurate at recognising faces of children than faces of adults (e.g. Anastasi & Rhodes, 2005; Kuefner, Cassia, Picozzi & Bricolo, 2008).

The majority of developmental face recognition studies show that our ability to accurately recognise faces increases throughout our childhood, reaching an asymptote in our teenage years. However it is possible that we can perform with adult-like accuracy at an even earlier age if the task demands are made relatively easier, particularly if the faces used as stimuli are of a more familiar age group (i.e. consist of *own-age* faces). Once



adulthood is reached, we are experts at recognising faces (Carey & Diamond, 1977; 1994) and we remain face experts for most of our adult lives.

#### *1.6.2. Becoming a Face Expert; The Development of Configural Processing*

One of the key issues that is discussed in the face recognition literature is whether children process faces in the same way as adults and simply get more efficient at doing so as they get older (a quantitative difference) or whether they use different processes and strategies to adults (a qualitative difference). One source of research that suggests the difference between adult and child performance is a qualitative one is that of Diamond and Carey (1986). They suggested that the developmental pattern observed for face recognition was due to a difference in the encoding strategies employed at different ages, with older children and adults relying more on configural processing and younger children encoding more piecemeal/featural characteristics. One study that lends itself to this notion of a qualitative encoding switch is that of Diamond and Carey (1977) who investigated age differences in the recognition performance for disguised faces. Their results revealed that children under 10 made significantly more recognition errors than older children and adults when facial images were disguised using misleading paraphernalia such as clothing, wigs, hats and glasses, supporting the idea that these children relied more on paraphernalia (piecemeal) cues than those older than 10 years of age.

Carey and Diamond (1977) further strengthened the encoding switch hypothesis using a recognition paradigm for upright and inverted faces. They found that children under the age of 10 recognised inverted faces as accurately as upright faces, whereas older children displayed an inversion effect similar to that of adults, with poorer performance on

inverted faces compared to upright faces. As inversion disrupts the encoding of configural features, older children and adults have to use a featural encoding strategy to recognise inverted faces, which is less efficient than a holistic strategy, hence the drop in performance. Carey and Diamond concluded that, as younger children's recognition is not affected by face inversion, they must be using featural encoding for upright faces as well as for inverted faces, therefore supporting the notion of a qualitative difference in facial processing.

However Carey and Diamond's interpretation of their findings has not gone unchallenged. For example, Flin (1985) suggested that the observed pattern of results may have been attributable to the difficulty of the task that Carey and Diamond employed. Specifically, Flin claimed that Carey and Diamond's inability to find an inversion effect in young children may have been the result of floor effects. Using a smaller selection of stimuli and longer exposure times to control for task difficulty, Flin found that children under the age of 10 years old do indeed demonstrate an adult-like inversion effect. In fact a more recent study has shown that when the task is appropriate for the age of the participant, children as young as 5 years old exhibit this adult-like pattern (Brace et al, 2001). In addition, Diamond and Carey (1977) themselves showed that children as young as 6 years old were able to perform in an adult-like manner when the faces used were suitably familiar to them, a finding replicated by Young and Bion (1981).

Studies using the Composite Face Effect have produced similar results. Carey and Diamond (1994) presented 6 and 10 year olds with composite (aligned) and non-composite (not aligned) photographs of personally familiar faces (their classmates) and asked them to identify the upper face portion of the face. The authors found that, like adults, both age

groups of children were slower to recognise composite faces than the non-composite faces. The presence of a composite face effect suggests that children as young as six exhibit an adult-like configural form of processing, perceiving the upper half of the face in conjunction with its lower counterpart and in the context of the face as a whole. This is a notion that is certainly supported by Tanaka, Kay, Grinnell, Stansfield and Szechter (1998) who, using a part-whole face paradigm, found children as young as six performed best at recognising target features when they were presented within the whole face rather than in isolation.

Together these findings suggest that while they are not as proficient as adults at face recognition, young children may still be able to use the configural information in the face. One study specifically sought to track the development of both featural and configural processing throughout childhood. Mondloch, Le Grand & Maurer (2002) carried out a face-matching task, where adults, and children aged 6, 8, and 10 years were asked to identify whether upright and inverted faces were the same, or if they had been altered in some way. Faces either differed in terms of the shape of the facial features (featurally different), the spacing between the features (configurally different), or in the external shape of the face. The authors found that children performed with adult-like accuracy by age 10 for the featural task. In contrast, while children demonstrated an ability to use the configural information in the face (i.e. they performed better than chance with the configurally changed faces and they exhibited an inversion effect) their accuracy on the configural task increased with age and did not reach adult levels. This suggests that while featural processing is fully developed at a young age, the ability to expertly use the

configural information in the face, an ability that is the hallmark of expert face processing, is not fully developed until after 10 years of age.

### *1.6.3. Beyond Expertise: Age Related Deficits in Face Recognition*

While, as young adults we are face experts, a number of studies have shown that as we approach old age our abilities appear to wane. A number of lab-based studies have investigated the face recognition abilities of elderly adults compared to young adults following the presentation of a large number of faces (e.g. Bartlett & Fulton, 1991; Bartlett, Strater & Fulton, 1991; Smith & Winograd, 1978). The main finding of these studies was that recognition performance was poorer for the elderly participants, and was particularly characterised by an increase in false recognitions of never-seen-before faces (and an increased perceived familiarity of those faces). A later study by Crook and Larrabee (1992) sought to shed more light on the decline of face recognition accuracy in late adulthood by tracking the performance of adults at every decade of their lives from 18-80 years old. Using a face recognition and delayed matching task, the authors found that age decrements in performance occurred as early as 50 years of age, with the sharpest decline occurring amongst those over 70 years old. This finding demonstrates that the age-related decline in face memory does not follow a linear pattern and is in line with more general memory research which has illustrated a similar acceleration in memory deterioration in those over the age of 70 years old (Parkin, 1997).

Evidence for an age-related decline in face recognition accuracy also comes from the eyewitness testimony literature. For example, in a study by Adams-Price (1992) young, middle-aged and older adults watched two short films in which a theft occurred. Following

each video, the participants were shown 15 mugshots of people, one of whom was the perpetrator, who they were asked to try and identify. The author found that age was significantly negatively related to identification accuracy, with older adults performing worse than the younger groups. This finding was similar to that of O'Rourke, Penrod, Cutler and Stuve (1989) who asked 18-74 year olds to identify the perpetrator of a previously viewed crime from a video line-up. O'Rourke et al found that this age-related deterioration in identification accuracy was most noticeable for adults over the age of 50 years old, and their performance was particularly impaired when the perpetrator was not present in the line-up. More recently, a number of further eyewitness-type studies using both target-present and target-absent lineups have replicated these findings confirming an increase in false identification rates and in many cases, a decrease in hit rates in old age (Memon, Hope, Bartlett & Bull, 2002; Memon & Bartlett, 2002; Searcy, Bartlett & Seipel, 2000; Searcy, Bartlett & Memon, 2000; Searcy, Bartlett, Memon, & Swanson, 2001).

An age-related decline in face recognition accuracy may not, in itself, be surprising given the amount of literature there is on the general memory and cognitive deficits related to old age (e.g. Grady & Craik, 2000; Hedden & Gabrieli, 2004; Salthouse, 2003; 2004). However, this observation may be misleading. The apparent decrease in face identification accuracy may not be entirely due to the characteristics of the observer (in this case their age), but may in fact, at least in part, be the result of the facial stimuli used in most face recognition studies. It is of note that in all of the above-mentioned studies, the facial stimuli and/or actors that were used were young adults. As a result, the younger adult groups were being asked to identify *own-age* faces, while the older groups were not. It may, therefore be the case that older adults are not necessarily worse at recognising faces

than younger adults, but are instead hindered in some way by the fact that the faces in the photographs do not belong to the same age group as themselves.

### **1.7 An Own-Age Bias in Face Recognition?**

Previous research has suggested that young adults are better at recognising faces and make more accurate eyewitness identifications than older adults (e.g. Adams-Price, 1992; Searcy, Bartlett & Memon, 2000; Searcy, Bartlett, Memon, & Swanson, 2001; Yarmey, 1993). While it is known that cognitive performance deteriorates with age (see Hedden & Gabrieli, 2004 for a review), this apparent difference in facial memory performance might be partly due to the nature of the stimuli that are commonly used in face recognition studies. For example, most of the studies that have looked at face recognition performance of different age groups have compared undergraduates (or those of a similar age group) with older adults. However the targets and distractors used in these studies are usually faces of college age. It is therefore possible that younger adults' superior recognition accuracy is the result of some kind of own-age processing bias.

It is of note that many of the studies investigating the phenomenon conceptualise the “own-age bias” differently. While some take it to refer to a recognition advantage for own age faces over other age faces, others take it to indicate an advantage of one group of participants over another when presented with faces belonging to their own age group. While initially these two interpretations may appear to be similar, they are in fact referring to two very different effects. For example, younger and older adults may be shown faces belonging to both age groups. Young adults may exhibit a recognition advantage for own-

age faces over faces of the older adults, and they may perform better than the older adult participants for the young adult faces. In this case, young adults would exhibit an own-age bias in terms of both definitions. In contrast, the older adults may perform better with faces belonging to their own-age group compared to faces of the younger adults, however their accuracy for recognising the older adult faces may be at an equivalent level to that of the younger adults. In this case, an own-age bias for the older adults would only exist in terms of the first definition offered. While both conceptualisations are important when researching the own-age bias, it is equally important to draw attention to and clarify these two meanings. As such, this thesis will refer to the “own-age bias” as meaning the relative advantage of recognising own-age, compared to other-age faces (the first of these two definitions), however as illustrated by the above example, both effects may occur simultaneously.

### *1.7.1. The Own-Age Bias in Adults*

Relatively little research has been performed on this topic, but the few studies that have been carried out do appear to provide evidence for an own-age bias in person recognition. For example, one of the earliest studies that sought to highlight the age of the witness as an important variable in eye witness testimony found that the age of the perpetrator interacted with how well the witness performed. List (1986) showed school children, university students and older adults sixteen videotaped vignettes of two shoplifting events, one of which was carried out by a young actress, and the other by a middle-aged actress. She found that when the actress was young, the older adults were significantly impaired at remembering the information about the perpetrator, however no

differences in memory were found when the older actress was used. In addition, both young and older adults performed best when the perpetrator was closer in age to themselves. List (1986, p. 56) suggested that this:

“differential memory advantage for information concerning the actress more relevant to themselves [might be] because self-reference enabled more elaborate encodings of this information... that is, information that is particularly meaningful in terms of the self may have created more associations in memory, thus enhancing performance”.

However, while this study certainly gives an indication of an own-age bias in face recognition, it did not investigate memory for faces *per se*. Instead, participants were asked to recall and recognise person characteristics, a task which, while relevant to face recognition, does not necessarily tap into their face recognition abilities. In addition, it is difficult to draw conclusions about own-age biases in person recognition when the two actresses were not matched to the ages of the participants. While no information is given about the actual age of the actresses, it is assumed that the young actress was approximately the same age as the young adult participant group. However, the older of the two actresses was described as middle-aged, and not as an older-adult, indicating that it is unlikely that she was in the same age band as the older adult participants. Given these two issues, it is difficult to draw any firm conclusions from this study in terms of an own-age bias in face recognition.

In a more recent study, the face recognition abilities of differently aged participants were specifically investigated using a similar eyewitness-style paradigm. Wright and Stroud (2002) presented young adults and middle-aged participants with videos of a crime in which the perpetrator was either similar or dissimilar in age to themselves. All participants were more likely to correctly identify the perpetrator from a line-up comprising



people belonging to their own age group. Both groups were likely to make a positive identification (approximately 47% of the time) when the perpetrator was of a similar age to themselves. However, when the targets belonged to the other age group young adults were only likely to recognise the culprit 37% of the time, compared to 24% of the time for the middle-aged adults. Further analysis revealed that while young adults were better than the older adults at recognising young adult faces, this difference did not reach significance for the older adult faces. While within-participant group analyses were not carried out in this study, the pattern of results indicate that an own-age bias may only have been present for the older adult group.

Similar results were found by Perfect and Harris (2003) using a paradigm to investigate unconscious transference. Following the presentation of four “mugshots” of people that participants were told had committed a crime, participants were asked to identify the perpetrators from four separate lineups. Perfect and Harris (2003) found that young adults were significantly better at recognising a young perpetrator (with 73% accuracy) than were the older adults (37% accuracy). In contrast, when the lineups comprised older adults, the performance for both age groups was comparable (80% for young and 83% for older adults). In addition, older adults were more likely than younger adults to misidentify a bystander as the perpetrator of a crime when the line-ups consisted of younger adults. This difference was eliminated when the line-ups were comprised of older adults.

Thus both of the above studies suggest that young adults out-perform older adults when viewing young faces, but this own-age advantage disappears when faces of older adults are used. And while not specifically analysed in either study, the accuracy scores

reported suggest that while older adults show an advantage for recognising own-age faces over other-age faces, younger adults may not. However before one accepts this interpretation there are a number of points to consider. Firstly, in an additional study using a similar procedure to that of Wright and Stroud (2002), no such effects of age were found (Memon, Bartlett, Rose and Gray, 2003), calling into question the reliability of these findings. Compounding this is the possibility that the study designs themselves may have been the cause of the effects that were found (or not). All three studies used forensic style methodologies which, while ecologically valid, are lacking in power (due to the small amount of data each participant contributes). In addition, the main issue with these eyewitness paradigms is that each face-age category is only represented by a small number of faces (two in all cases) and as such the accidental use of atypical exemplars may have biased the participants' performance in some way. To reduce the possibility of this occurring and to increase the power of the studies, more traditional recognition memory tasks following exposure to a large number of photographic facial stimuli have also been used to investigate the own-age bias.

In one of the earliest studies to be carried out on the possible own age bias in face recognition, Bartlett and Leslie (1986) investigated the recognition performance of young and old adults for younger and older faces. In two experiments the authors presented participants with 48 faces which they were then required to remember and later identify from a larger pool of facial stimuli. Using signal detection theory to analyse the findings the results of both experiments showed that the younger participants were more accurate at recognising faces of their own age compared to faces of the older age group. In contrast, no such own-age advantage was shown for the older adult group. These findings are in line

with those of Mason (1986), Fulton and Bartlett (1991) and Wiese, Schweinberger and Hansen (2008) who all found that young adults were better at recognising younger adult faces than older ones, while older adults' performance was similar for faces of all age groups.

These findings suggest that while young adults exhibit an own-age bias, older adults do not. However, this may not necessarily be the case. In all four of the aforementioned studies the matching of ages between the facial stimuli and the participants may have been flawed, particularly for their older adult groups. For example, Fulton and Bartlett (1991) grouped together participants aged 59-82 years old and showed them photographs of “own-age” faces with an average age of 62.7 years. Similarly, Mason (1986) used 62-88 year olds to make up their older adult group. However it is highly unlikely that adults aged in their late 50s and early 60s would consider themselves to be in the same age band as somebody in their 80s (and vice versa).

In addition, the changes that happen to the face during those years are quite substantial (see Section 1.5.1). Bartlett and Leslie made a similar mistake with the age band they used to make up their “older adult” facial stimuli, using faces between 40-79 years old. This is a huge age range and is unlikely to constitute a single conceptual, or perceptual, age band. Similarly, while the study by Wiese et al used slightly ambiguous phrasing to describe the age bands of the faces they used (stating that “240 pictures showing 120 old (mean age  $69 \pm 7.2$  SDs) and 120 young faces (mean age  $22 \pm 3.0$  SDs)”), personal communication with the author revealed that this equated to a range of 55-82 years (almost double the age-range for the older participants, who were 61-76 years old) and 18-29 years respectively. Considering this, it is possible (if not likely) that the pattern seen for

the older adults' face recognition abilities in these studies is not indicative of a lack of own-age bias in this group, rather it is due to the fact that there is no coherent "own age" facial stimuli group. Thus the pattern observed is that of two *other-age* group recognition effects.

One study that has shown a full cross-over own-age bias is that of Bäckman (1991). In this study there were four groups: young adults (19-27 year olds), older adults (63-70 year olds), 76 and 85 year olds. Each group was shown photographs of younger (mean = 29.5) and older (mean = 76.2) adults. While the two elderly groups performed generally badly (in line with the general effects of ageing on memory performance) and showed no effects of face age overall, the other two age groups both showed significant own-age biases, recognising faces belonging to their own age group better than those belonging to the other age group. While the age bands used for the older adult groups were suitably small for both the participants and the photographs used, they hardly overlapped. This lack of matching again makes it difficult to interpret these results as showing an unequivocal own age bias in younger and older adult age groups.

One recent study that sought to eliminate the issue of inappropriately aged stimuli investigated the ability of young (18-25 years old), middle-aged (35-45 years old) and older adults (55-78 years old) to recognise faces belonging to those exact three age bands (Anastasi & Rhodes, 2006). The authors found that adults belonging to each age group exhibited superior recognition for own-age faces compared to other-aged faces (although it is of note that using in excess of a 20 year age band to represent the older adult group may be problematic). This full cross over own-age effect has also been replicated by Perfect and Moon (2005) who found a robust age x face-age interaction for upright faces, characteristic of the own-age bias, after showing photographs of younger (mean = 22.2 years old) and

older adults (mean = 73.4 years old) to two groups of similarly aged participants (means = 20.2 and 73.9 years old, respectively). Both age groups showed enhanced performance with own-age faces.

The above review illustrates that previous research into the own-age bias in young and older adults has produced contradictory findings. While some studies have reported an own-age bias only in young adults (e.g. Mason, 1986; Barlett & Leslie, 1986; Fulton & Bartlett, 1991), others have reported the additional presence of an own-age bias for older adults (e.g. Anastasi & Rhodes, 2006; Perfect & Harris, 2003). One of the main reasons for these inconsistencies may be the fact that the majority of these studies have failed to successfully match the age of the participants with the ages of the stimuli used. As such, it is possible that the lack of own-age bias in the older adults is actually a product of the fact that they have not actually been presented with any “own-age” faces. This notion is supported by the fact that the only two studies managed to successfully match their stimuli and participant age groups have shown an own-age bias in both the younger and older participants. It therefore seems likely that when the stimuli are well matched to participant age and a robust experimental design is used, all adult age groups exhibit an own-age bias in face recognition.

### *1.7.2. The Own-Age Bias in Children*

The majority of work with the own-age bias in face recognition has explored the issue using younger and older adults, both in terms of participant and stimulus ages. Very few studies have extended this work to investigate whether this own-age bias exists in children, and indeed whether young adults exhibit a similar own-age bias when presented

with own-age and children's faces. As with older adults, children are generally thought to perform relatively badly in face recognition tasks, only reaching adult-like levels of performance in their teenage years. However, as discussed in Section 1.6. (and in a similar way to older adults), this may, at least in part, be a product of the fact that the majority of face processing studies use young adult faces as their facial stimuli. Indeed, some studies have shown that children perform in a more adult-like fashion in face processing studies when the facial stimuli presented are similar in age to themselves (e.g. Feinman and Entwisle, 1976; George, Hole & Scaife, 2000).

One study that sought to investigate the potential presence of an own-age bias in children (and in a group of older adults) was that of Anastasi and Rhodes (2005). In this study the two groups of participants were shown photos of children and young, middle and older aged adults and later asked to try and identify them from a larger group of facial stimuli. Both groups showed superior recognition for faces belonging to their own-age group, compared to faces of the other age groups. However, part of the procedure of this study involved categorising the facial stimuli into age groups at the learning stage. This may have actively drawn participants' attention to the ages of the faces and encouraged a related processing bias. So while both children and older adults exhibited an own-age bias, this may have been induced by the categorisation process in the learning phase of the study.

Two other studies have also investigated the possibility of an own-age bias in children. Chung (1997) tested children aged 7, 9, 10, 11 and 12 years, and adults for their recognition of adult and children's faces. While the results showed a general increase in recognition accuracy with age, they also revealed that adults recognized adult faces more accurately than children's faces. In contrast no own-age bias was found for the child

participants. In contrast to this Crookes & McKone (2009) found the opposite pattern, with children demonstrating better recognition of child faces than adult faces, while adults exhibited no such bias. However as with the studies conducted with only adult groups, it is possible that these findings may have been the result of the methodologies used. While both used traditional old/new recognition paradigms, and thus power is unlikely to be a problem, the latter two studies may not have successfully matched the participant ages to those of the facial stimuli used. Indeed Crookes and McKone themselves admit that they “only defined ‘own-age’ broadly to simply mean child versus adult status, rather than attempting to match exact age[s]”. As such, these studies may not have truly been investigating the presence of an own-age bias in the face recognition abilities of children and it remains unclear whether such a bias exists for this age group. Clarifying this issue was one of the initial aims of this thesis.

In addition to the above study, two more have investigated the possibility of an own-age bias in young adults who are presented with both own-age and children’s faces. These will be further discussed in Section 1.9.2.

## **1.8 Reasons for an Own-Age Bias in Face Recognition: What Other Biases in Face Recognition Can Tell Us.**

As discussed in the preceding section, previous research has shown that we recognise faces similar in age to ourselves better than older or younger faces (e.g. Anastasi & Rhodes, 2006). However, while this research has provided evidence for an own-age bias in face recognition, the question of why this phenomenon might occur and what underlying

mechanisms may produce it, remains unclear. In order to try to establish possible reasons for the existence of an own-age bias, it might be informative to consider other processing biases that appear in the face recognition literature. Perhaps the most well known of these is the own-race bias (or cross race effect). It is well established that people are generally more proficient at recognising faces belonging to their own racial group compared to those from a different, less familiar race (for reviews see Meissner & Brigham, 2001; Sporer, 2001; Brigham, Bennett, Meissner & Mitchell, 2007). And, while a lot less researched, there is also evidence that we may be better at recognising faces of our own gender relative to those of the other gender (e.g. Wright and Sladden, 2003). It may or may not be the case that the own-race and/or own-gender biases are analogous to the own-age bias, however the theories put forward to explain these biases in face recognition serve as a useful starting-point for this research.

### *1.8.1. The Own-Race Bias in Face Recognition*

People find it more difficult to accurately recognise the faces of people of other races relative to their own. For example, Meissner and Brigham's (2001) seminal paper on the own-race bias reported a meta-analysis of thirty-nine studies which investigated the cross-race effect and found that participants were approximately 1.40 times more likely to correctly identify a previously viewed own-race face than an other-race face. Indeed, there was a large effect size of .82 for this own-race recognition advantage, indicating that the own-race bias is a robust phenomenon. In addition to a recognition deficit for other-race faces, Meissner and Brigham also found an increased tendency for participants to classify



faces belonging to a different race as “seen before”, irrespective of whether or not they had been previously seen, indicative of a shift in response bias for other-race faces.

In a forensic setting these findings suggest that if a suspect is of a different race to a witness, then the witness will have a decreased probability of making a correct identification and an increased probability of making a misidentification. Additionally, a shift in response bias to a lower criterion threshold for other-race faces means that a witness is more likely to make a false positive identification if the lineup comprises members of a race that is not their own. In fact, it is this phenomenon that has been labelled as one of the main causes of faulty eyewitness identifications. As discussed in Section 1.4, eyewitness misidentification has been identified as the leading cause of wrongful convictions for cases where DNA evidence has led to the exoneration of the falsely accused (Brandon & Davies, 1973; Conners, Lundregan, Miller, & McEwen, 1996; Scheck, Neufeld, & Dwyer, 2000). Compounding this, Wells and Olson (2001) and Scheck et al (2000) have suggested that the own-race bias may play a large role in these faulty identifications, both studies demonstrating that for a large proportion of these exonerations, one of the key witnesses involved was of a different race to the perpetrator.

Although the own-race bias has been replicated numerous times and is accepted as a reliable and robust phenomenon, its genesis remains unclear. However we know that it does not occur as a result of faces from one racial group having a different amount of physiognomic variability than another. For example, Goldstein (1979) found that Caucasian, Black and South-East Asian faces showed similar *amounts* of variability between same-race faces. However, Goldstein also found that there were differences in the *types* of facial variability that were important for distinguishing between faces of each race

(for example, while eye and hair colour may play an important role in discriminating Caucasian faces, this may not be the case for African faces; Ellis, Deregowski, & Shepherd, 1975). It therefore seems possible that the own-race bias occurs as a result of learning what facial features/properties are important to attend to when recognising and distinguishing between faces. If this is the case, then it follows that this learning experience is most likely to be the result of the facial stimuli that we are most commonly exposed to.

#### *1.8.1.1. The Contact Hypothesis and the Own Race Bias in Face Recognition*

While there is no unified theory of what causes the own-race bias, perhaps the best known explanation is that of “the contact hypothesis”. This proposes that people become experts at differentiating faces of their own race as a result of increased contact with members of their own race compared to those of other races (e.g. Brigham & Malpass, 1985; Chiroro & Valentine, 1995). It is therefore not the result of the faces belonging to the same race as the perceiver per se, but a function of the fact that we tend to have relatively more experience with own-race faces. This explanation of the own-race bias has been supported by a number of studies that have demonstrated a significant positive relationship between memory for faces of individuals from a certain race and the amount of contact the participant has had with that race. For example, Meissner & Brigham’s (2001) meta-analysis of 29 studies that used self-report measures of inter-racial contact found a significant relationship between this measure and other-race discrimination. Though, it is of note that their finding only explained about 2% of the variability in the data, calling into question the robustness of this explanation of the other-race effect.

However, using self-report measures to estimate exposure may be problematic, as self report may be distorted by inaccuracies of memory and response biases (i.e. a tendency to over or underestimate). The accuracy of this contact information could be called into question, given that participants were being asked to provide details of exposure to other-race faces, some extending back in time over the course of their lifetime. It is likely that this kind of report inaccuracy would reduce the chance of finding significant associations between other race contact and the ability to recognise faces belonging to that racial group. Thus the finding of any significant relationship between these two variables suggests that contact may indeed play an important role in the own-race bias.

An additional issue one is faced with when attempting to find a relationship between contact and memory performance with other-race faces is that this kind of analysis assumes a linear relationship between the two variables, which may well not be the case. The concept of “contact” as a variable is not just as a quantitative measure of time spent with other race faces; there are also more qualitative aspects to consider, such as attentional and motivational factors.

Given the potential problems with self reported contact information, some studies have investigated the effects of other-race experience by operationalising contact frequency into “high” and “low” contact groups. One example of this can be seen in an unpublished, but frequently cited study by Li, Dunning & Malpass (1998). They found that white participants who frequently watched NBA basketball (where the majority of players are black) exhibited less of an own-race bias than participants who were basketball novices. This finding certainly supports the contact hypothesis, although it does not distinguish between the aspects of contact that may be responsible for such an effect. For example, the

basketball fans would no doubt have an increased quantity of contact with black faces, however they would also have an increased quality of contact with them, specifically attending to the individuals on the basketball court as a result of following the sport. It is this issue of quantity versus quality that needs to be further explored when considering the role of contact in the own-race bias.

One study that gives us further insight into the contact hypothesis is that of Chiroro and Valentine (1995) who investigated the own-race bias in four groups of participants with varying inter-racial contact. In this case, the amount of contact with other races was estimated based on the participants' geographical whereabouts and opportunities to interact with members of other races. The two high contact groups comprised students from a multiracial college in Zimbabwe, which allowed for a high degree of daily contact with other-race faces. One group consisted of white Africans, the other of black Africans. For the white low contact group, British students from a college in a small village in England were recruited (although due to the ubiquitous nature of the media in the UK, it is likely that these students would have had some exposure to other-race faces). The low contact black participant group comprised students from a small school in a remote village in Zimbabwe (in contrast to the white low contact participants, this group was unlikely to have seen any white faces through any media sources).

Using A-prime as a measure of accuracy, Chiroro and Valentine found that both of the low contact groups were significantly more accurate at recognising own-race faces compared to other race faces. For the black participants, this own-race bias was completely eliminated for the high contact group, suggesting that contact does mediate the own-race bias. However, while the effect of contact was significant for the black participants, this

was not the case for the white high contact group who still exhibited an own-race bias (albeit slightly attenuated). While this latter finding may initially appear to contradict the hypothesis that contact mediates the own-race bias, it is worth considering the differences between the groups of participants that were used in this study. The differences between the amount of inter-racial contact for the two groups of black participants may have been significant (in that high contact group had daily exposure to white faces, while the low contact group had almost no contact with white faces over their lifetime, and no televisions that might allow exposure to white faces in the media). However, this difference may not have been so pronounced between the two white contact groups. Unlike the remote village in Zimbabwe, the rural village in the UK would not have guaranteed such low-levels of contact with other race faces due to the pervasiveness of the media in England, and the amount of black celebrities who regularly feature in the media. As such it is possible that the difference between the white participant groups may not have been large enough to produce a significant effect of contact.

While this line of reasoning can explain why there was a significant effect of contact for the black, but not white participants, it does not explain why the high contact white group still exhibited an own-race bias. Surely if contact plays an important role in the own-race bias, this increased daily contact with black faces should have resulted in a similar pattern of results to that exhibited by the high-contact black participants. However, before assuming this, one really needs to take the results of this study in terms of a wider context. In a country like Zimbabwe where racial segregation was practiced under white minority rule until only three decades ago, it is possible that the two races would have had very different motivations for interacting with members of the other race. It is possible that

due to the country's history, even though white participants encountered black Zimbabweans, they may not have been attending to them. If this was the case, then it could be said that it is not only the quantity, but also the quality of contact that may play an important role in the own-race bias.

A more recent study by Wright, Boyd and Tredoux (2003) provides further supporting evidence for the interplay between quantity and quality of contact in mediating the own-race bias. Three groups of University students with varying levels of inter-racial contact took part in this study. Two groups comprised white students; one from Bristol University and one from the University of Cape Town. Both of these groups were assumed to have relatively little contact with other-race (in this case black) faces as a result of there being few black students at Bristol University and due to the recent abolition of apartheid in South Africa. The third group comprised black students from the University of Cape Town who, in contrast to the other two groups, had a higher degree of other-race contact, most likely due to the high proportion of white individuals at the University.

Using an old/new paradigm, Wright et al (2003) asked participants to look at, and later identify a number of black and white faces. Indicative of an own-race bias there was a significant group x race of face interaction, with white participants performing more accurately for white faces than black faces. Interestingly, however, the black participants also performed better with white faces, although this advantage was much less pronounced than for the other two groups. This pattern emerged despite the black participants most likely having quantitatively more exposure to own-race faces compared to white faces (the population of South Africa being approximately 79% black and only 10% white;

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<http://www.info.gov.za/view/DownloadFileAction?id=85218>). Wright, Boyd & Tredoux (2003) suggest that this finding may be the result of the fact that a disproportionate amount of people in positions of power and of academics within the University of Cape Town are white, implying that quality of contact may play an important role in mediating the own-race bias. In addition, the authors also provided evidence for the quantitative influence of contact in the own-race bias in this group. Using a short questionnaire to estimate the level of inter-racial contact this group had, they found a significant positive relationship between contact and the black students' other-race recognition accuracy.

In summary it appears that experience may play an important part in the own-race bias, and that both quantity and quality of contact may make significant contributions to this relationship. However the contact hypothesis is a “high level” theory that gives a general account of the own-race bias without explicitly referring to any of the processes that may give rise to this phenomenon. As such it remains unclear precisely what cognitive, perceptual and/or social mechanisms may underlie this effect.

#### *1.8.1.2. Perceptual Expertise and the Own Race Bias in Face Recognition*

A number of explanations have been put forward to try and detail the cognitive mechanisms that may be responsible for the own race bias. The most popular explanation of this kind is couched in terms of a lack of perceptual experience (and therefore expertise) with encoding the facial properties of other, less familiar races. Essentially this account proposes that increased contact with a race (usually our own) gives rise to improved perceptual processing for that particular facial group as a result of learned perceptual expertise.

As described in Sections 1.1. and 1.2., as adults we are experts at processing faces. According to the expertise hypothesis of face recognition, our ability to process faces at a superior level to other objects is a result of a wealth of experience with recognising and distinguishing between faces at exemplar level (e.g. Gauthier & Tarr, 1997; 2002). If this expertise with faces depends on perceptual leaning experience, then this explanation may also be appropriate in explaining the own-race bias in face recognition. For example, if we have more experience and contact with certain groups of faces (i.e. those of our own race) than others (i.e. those of another race), does this mean that we are more expert with that group of faces?

In order to investigate the possibility that the own-race bias is a function of expertise for own-, but not other-, race faces we can look at participants' performance on tasks which tap into our ability to successfully use the facial information which is known to be at the heart of expert face processing: the configural information. Section 1.2. describes how inversion, part-whole and composite face manipulations can interfere with our ability to process faces configurally. If own-race faces are processed in a more expert (and hence more configural) manner than other race faces, then one would expect to see these manipulations interfere with the processing of own-race faces to a greater extent than other-race faces.

One of the earliest studies to address this *configural-expertise* explanation of the contact hypothesis was that of Rhodes, Tan, Brake, and Taylor (1989). In the first experiment reported in this study, European and Chinese participants were presented with photographs of faces belonging to both racial groups. Following the study phase, participants were then given a forced choice recognition test where they had to identify



which of the faces they had seen before. In the recognition tests half of the faces were presented upright, while the other half were inverted. Both groups of participants showed a larger effect of inversion (as measured by a percentage increase in reaction time relative to upright performance) for own-race faces. In a second experiment Rhodes et al (1989) attempted to eliminate ceiling effects through the reduction of exposure time and increase in the amount of stimuli used in the study phase. In doing this they extended their findings to show a larger inversion decrement for own-race faces in terms of accuracy.

In a more recent study of the inversion effect, Hancock & Rhodes (2008) specifically sought to track how inter-racial contact affected the size of the own-race bias and the use of configural processing. By assessing inter-racial contact using a seven item questionnaire, the authors found that participants with higher other-race contact exhibited a reduced own-race bias for both Caucasian and Chinese participants. In addition, these participants exhibited a significantly larger inversion effect for own race faces, again supporting a *configural-expertise* explanation of the own-race bias. Using inversion decrements as an index of configural processing, the authors found that participants with higher inter-racial contact displayed little difference in the amount of configural processing they used to process faces belonging to either racial group. Crucially, Hancock and Rhodes found that the difference in the amount of configural processing used to process own and other race faces significantly predicted the size of the own-race bias the participants exhibited. These findings directly lend support to the hypotheses that 1.) the own race bias is mediated by inter-racial contact and 2.) that this stems from enhanced configural processing as a result of learned perceptual expertise.

The perceptual expertise account of the own-race bias has also been investigated using paradigms other than inversion. As the inversion effect is an indirect measure of configural processing, other researchers have sought to use more direct methodologies. For example, while inversion is assumed to be an index of configural processing, this is based on previous research showing a disproportionate disruption of face recognition performance compared to recognition of other objects following rotation. In fact little is known about the exact nature of inversion and the disruption it produces to the processes involved in face recognition.

While previous researchers have interpreted large inversion decrements as indicative of enhanced configural processing, implying that inversion selectively disrupts this type of information in the face (e.g. Diamond & Carey, 1986; Valentine, 1988), more recent evidence has intimated that featural processing is also affected by this manipulation (e.g. Mondloch, Le Grand & Maurer et al, 2002; Rhodes, Hayward & Winkler, 2006). It is therefore difficult to draw firm conclusions about the degree of configural processing that has taken place based purely on inversion studies. Instead, one would need to use a methodology that specifically manipulated the spatial relationships between the facial features.

One of the most convincing demonstrations of the role of configural processing in face perception is the composite face effect (described in Section 1.2.1.). In this paradigm, the recognition of the top half of a person's face is made more difficult by aligning it with the bottom half of a different face. This creation of a composite face produces a new facial configuration and the perception of this whole, apparently novel face overrides our ability to recognize its constituent parts (e.g. Tanaka & Farah, 1993). Using this paradigm,

Michel, Rossion, Han, Chung and Caldara (2006) showed Caucasian and Asian participants twenty faces from each racial group which they were told to commit to memory. Following this, they were asked to identify the top halves of those faces from composite faces that were presented either in alignment, or out of alignment. Not only were both groups of participants better at recognizing faces of their own race, they also showed a greater composite face effect for those faces (i.e. recognition of own-race faces was impaired to a greater extent than that of other race faces when they were presented as a perceptually aligned whole, compared to when they were misaligned). This finding demonstrates that own race faces elicit more configural processing than other race faces.

Similar conclusions have been drawn from studies using the part-whole paradigm (described in Section 1.2.1.), where Caucasian and Asian participants were asked to recognize features belonging to faces of both races presented either in isolation, or set within the whole face (Michel, Caldara & Rossion, 2006; Tanaka, Kiefer & Bukach, 2004). In both studies Caucasian participants were found to show a classic whole face advantage only for own race faces, while Asian participants performed comparably for faces belonging to both racial groups. In both cases the Asians reported having higher interracial contact than the Caucasians. As such, this pattern of results was interpreted by both sets of authors of being indicative of the important role that experience (and expertise) plays in the development of efficient configural processing skills for other race faces.

Expertise has also been identified as an important factor in the development of the own-race bias by research outside of the behavioural research domain. In a functional imaging study, Golby, Gabrieli, Chiao, and Eberhardt (2001) carried out a standard old/new face recognition paradigm with European-American and African-American participants for

faces of both racial groups. Participants were scanned during the initial viewing stage of the stimuli and the recognition test took place outside the scanner. The authors found that both groups of participants performed better for faces that belonged to their own-racial group, exhibiting the classic own-race bias behaviourally. In addition, the Fusiform Face Area (the brain area associated with greater perceptual expertise with a homogenous class, see Section 1.1.2. for further discussion of this) showed a significantly greater activation pattern when participants viewed own-race faces compared to other-race faces. The authors also found that differential FFA activation for same- and other-race faces was significantly correlated with memory score differences for own- and other-race faces. This further supports the notion that expertise with own-race faces may be responsible for the own-race bias. However, in themselves, differences in the pattern of activation in the FFA do not necessarily present direct support for an increased perceptual tuning explanation of the own-race bias. Blood-oxygen-level dependent (BOLD) responses are known to be modulated by the degree of visual attention paid to the stimuli (O'Craven, Downing, & Kanwisher, 1999; Wojciulik, Kanwisher, & Driver, 1998), so it is possible that the differential pattern of activation seen in this study may have been the result of relatively increased interest in and attention to own-race faces. This type of account could also explain the own-race bias in general, with increased attention to own-race faces giving rise to better memory for those faces. This idea will be discussed further in Section 1.8.1.4.

Another explanation of the own-race bias that hypothesises enhanced perceptual processing as its basis is Valentine's (1991) multi-dimensional face space model. Rather than suggesting a difference in the amount of configural and featural processing that occurs for own- and other-race faces, this account suggests that all faces are encoded in the same

way, but that experience modulates the efficacy with which this is done. Valentine suggests that all faces are represented as points in a multidimensional space, whose dimensions consist of the facial characteristics that would best serve to discriminate between faces. Exactly what these dimensions are is speculative, however it is suggested that they develop as a result of our experience with faces. The idea is that through experience we learn what aspects of a face are important for successfully differentiating them and dimensions develop accordingly. Essentially this theory explains the own-race bias by suggesting that a lack of exposure to other-race faces results in poor development of the dimensions necessary for individuating those faces compared to those necessary for discriminating between own-race faces.

For example, previous research has shown that different facial features are of varying importance when distinguishing between faces of different races. Shepherd and Deregowski (1981) identified the internal lower facial features as being most important in differentiating black faces, but as being relatively unimportant for white faces, accounting for approximately 75% of the variation in black faces, but only 35% for white faces. In line with this, Ellis et al (1975) found that black and white participants relied on very different facial features when describing a face. While black participants commonly referred to facial outline, eye size, eyebrows, chin and ears as important identifying features, white participants relied more heavily on hair colour, texture and eye colour.

According to a perceptual expertise account of the own race bias, our experience with faces leads to the development of the most appropriate dimensions needed to successfully individuate those faces. As we are typically most exposed to faces of our own race, this would mean that while white participants may develop robust dimensions along

which they can successfully encode other white faces (e.g. according to their hair colour, texture and eye colour), dimensions which would best serve to discriminate other race faces go relatively under-developed. As such, while own-race faces are individuated with ease, other-race faces are more difficult to recognise.

In order to test this explanation of the own-race bias, Hills & Lewis (2006) carried out a perceptual learning task in which Caucasian participants were trained to identify faces using the cues in the lower facial features. Their reasoning was that if white participants were taught how to use the cues that are most useful in differentiating other-race faces, in this case black faces, then they should exhibit a reduced own-race bias after training. Consistent with a perceptual expertise account of the own race bias, the authors found that after only one hour of this type of training, participants exhibited a smaller own -race bias, while those who did not receive any training and those who did receive training, but with non-critical facial features (i.e. those that differ according to features extraneous to the face) showed no such reduction.

In summary, a couple of theories have been put forward that attempt to explain the own-race bias in terms of enhanced perceptual face processing mechanisms for own-race faces as the result of greater experience. This may be the result of different types of processing strategies associated with differing amounts of expertise (i.e. enhanced configural processing for own-race faces) or the result of a better developed, more appropriate encoding mechanism for own-race faces. While contact is obviously important for the development of expertise, it may not necessarily be the quantity of contact that is important, rather the quality of this contact that plays a pivotal role.

### *1.8.1.3. Social Categorisation and the Own Race Bias*

An alternative type of explanation for the own-race bias focuses on the social psychology of person recognition. These types of theories suggest that automatic social categorization of faces according to whether or not they belong to our own in-group (e.g. our own race), may influence the way in which we subsequently process these faces (e.g. Levin, 1996, 2000; Sporer, 2001). Social psychology research has suggested that people think categorically about out-group members, processing them according to social categories (e.g. race, sex and age) at the expense of individuating information (e.g. Bodenhansen, Macrae & Hugenberg, 2003). Exactly which facial characteristics are deemed important for categorisation is unclear, although List (1986) suggested that broadly categorical self-referential information and socially important shared characteristics are most likely to be at the heart of this process (e.g. age, sex, race, attractiveness). This is in line with research in the social psychology domain which has illustrated that the act of using self-referent encoding strategies (i.e. relating viewed stimuli to the self) results in better recognition memory for stimuli (Symons and Johnson, 1997).

One theory that concentrated specifically on the effects of categorizing faces according to race is Levin's Race-Feature Hypothesis (1996; 2000). Levin suggested that on viewing a face we immediately determine whether or not it belongs to our own-racial group or whether is of another race. This work was primarily based on his findings from experiments in which participants were asked to classify faces as belonging to their own or another race. Levin (1996) found that in addition to exhibiting the cross-race recognition deficit, almost paradoxically, participants were faster at identifying the race of other race faces (the so called Other-Race Classification Advantage; ORCA). As a result of this

Levin hypothesized that the own-race bias and ORCA occur as a result of an automatic emphasis of visual information specifying race at the expense of individuating information when recognising other-race faces (Levin, 2000). He suggested that for other-race faces, people code race-specifying information as an important facial feature, while own-race faces have no such feature. When processing an other-race face, the presence of this racial feature is detected and further visual processing does not take place, so that individuating facial features are not encoded. This essentially results in other-race faces being processed according to prototypical information, while own-race faces are individuated and processed at an exemplar level. Consistent with this theory is the ‘out-group homogeneity effect’, where out-group members are perceived as being more homogeneous than in-group members in terms of both personal and physical attributes (e.g. Judd & Park, 1988; Linville, Fischer & Salovey, 1989; for a review, see Mullen & Hu, 1989).

In an attempt to extend Levin’s work and to include a more detailed explanation of the underlying cognitive processes that may be involved in this type of social categorization, Sporer (2001) developed his In-group/Out-group Model (IoM) of the own-race bias. The IoM suggests that in-group faces are encoded in an automatic, configural manner (typical of expert face processing) according to the dimensions of the face that are particularly useful for discriminating it from other in-group faces. In contrast, out-group faces automatically trigger a categorisation of that person as belonging to an “out-group”. This categorisation process leads to these faces being processed in a different, less efficient manner than in-group faces, resulting in poorer recognition. Specifically, Sporer suggests that this out-group categorisation may result in fewer cognitive resources being given to those faces, leading to more shallow (e.g. featural) encoding strategies. One of the merits



of the IoM in terms of this thesis is that Sporer specifically claims that it can be extended to explain other own-group biases in the facial memory literature, such as the effects of age (e.g. Wright & Stroud, 2002) and gender (e.g. Slone, Brigham, & Meissner, 2000).

MacLin and Malpass (2001) also investigated the nature of categorisation in the own-race bias by examining whether this categorisation strategy depended on physical facial properties or whether it stemmed from more socially driven mechanisms. In order to do this, ambiguous race (half Hispanic, half African-American) face morphs were shown to participants belonging to both racial groups. These faces were then given either typically Hispanic, or typically African-American hairstyles to test whether the alteration of one simple visual cue could lead to the differential categorisation and processing of what is essentially the same face. The authors found that both groups of participants showed better recognition for faces that were shown with the hairstyles that were characteristic of their own racial group. Interestingly, altering the apparent race of the face also altered some of the perceived physical properties of that face. For example, composites that were categorized as African-American were described as being darker skinned, having wider mouths and less protruding eyes than the same faces that were categorized as Hispanic. Thus, changing the categorisation of a face based on the alteration of one simple cue can affect the way in which that face is perceived, processed and subsequently recognized.

Based on these findings MacLin and Malpass (2001) suggested that the recognition deficit for other-race faces is not necessarily caused by a lack of experience with members of that race as the perceptual learning hypothesis would predict, but by the categorisation of a face as belonging to another race. However, it is of note that changing the hairstyle of a face to influence its apparent race is still altering a physical feature of that face. As it has

previously been shown that external features play an important role in the processing of unfamiliar faces (e.g. Ellis et al, 1979), it is possible that the pattern of results found in this study may still have been an effect of expertise with one racial group over another.

Hilliar and Kemp (2008a) furthered this research by investigating the effect of an entirely non-physical racial cue on race perception and memory. Again the authors used identical ambiguous race face morphs, in this case producing South-East Asian and European-Australian morphs, as well as facial stimuli belonging to each racial category. On presenting participants with the faces, facial stimuli appeared paired with a randomly assigned name. South-East Asian and European-Australian faces were assigned race-congruent names, while half of the ambiguous race faces were given typically South-East Asian names and the other half, European-Australian names. Appearance ratings revealed that ambiguous multi-racial faces given more European-Australian names appeared to be more European, while the opposite was true for those same faces given typically South-East Asian names. Thus the authors conclude that the perception of the faces could be influenced by non-physical racial cues. This suggests that the presence of a race feature (be it physical or otherwise) leads to the automatic categorisation of that face as either own- or other- race which subsequently affects how that face is perceived and processed.

Further unpublished work by Hilliar and Kemp (2008b) has shown that the presentation of racially stereotypical names with ambiguous faces can induce a perceived own-race bias for those faces, however they only found this pattern when they used a specific blocked design. For example, if they presented participants with ambiguous faces given Caucasian names, they first had to expose them to Asian faces given Asian names (and vice versa with the ambiguous faces given Asian names). When a blocked design was

not used, no induced own-race bias was found. The authors suggest that blocking the stimuli allowed them to take advantage of perceptual after-effects; that is, after showing participants Asian faces, ambiguous faces appeared more Caucasian (and similarly when they were first presented with Caucasian faces, ambiguous faces look more Asian).

Interestingly Hilliar and Kemp also note that while these perceptual after-effects are not enough to induce an own-race bias for ambiguous faces on their own, when combined with a racially-typical name, it can occur. While it should be noted that this finding is yet to be replicated, it presents an interesting case for the importance of categorisation in the own-race bias.

If categorisation is at the heart of the own-race bias then it might also offer a different solution to reducing its effects than that offered by the perceptual expertise account. While the expertise model relies on other-race training to ameliorate the own-race bias, a social-cognitive model where in- and out- group categorisation elicits either the processing of individuating or categorical/prototypical information (respectively) does not necessarily have a place for contact/experience (although it may play some part in the development of socially defined in- and out- group categories). In this case, if categorisation into in- or out-groups is responsible for the own-race bias then one may be able to reduce it by altering the social categorisation process.

A study by Hugenberg, Miller and Claypool (2007) sought to investigate exactly this claim. Over three experiments the authors presented European-American participants with photographs of black and white individuals. Before the learning phase participants received one of three sets of instructions. The control condition instructions only informed the participants that they would be undertaking a memory test, while the experimental

instructions were either aimed at encouraging participants to individuate other-race faces, or at increasing their motivation to attend to the faces. The authors found that when given instructions to individuate other-race faces, the own-race bias (that was present for both the control and motivation condition) was eliminated, supporting a social categorisation explanation of the own-race bias in face recognition.

In summary, the social categorisation account of the own-race bias suggests that upon viewing a face, we automatically categorise it according to whether or not it belongs to our social in-group (e.g. our own race, age, gender) and this influences the way in which we subsequently process that face. This categorisation leads to the processing of out-group faces according to category-specifying/prototypical information at the expense of individuating information. In terms of the own-race bias, faces that are characterized as belonging to our in-group are therefore processed more efficiently and deeply, at an exemplar level, while out-group members are processed in a shallow, featural manner. As a result, own-group faces are better encoded and subsequently recognized, thus the own-race bias occurs.

#### *1.8.1.4. Motivation, Attention and the Own Race Bias*

A final explanation of the own-race bias in face recognition, which was alluded to in Section 1.8.1.2., also suggests that contact *per se* may not affect face processing directly. Instead, it may reflect or drive the degree of interest a person has in faces of a particular kind and the resultant amount of attention allocated to them. It is this motivation to attend to certain types of faces (e.g. own-race faces) that may be the important factor in determining how expert we become at processing those faces, perhaps due to the social

rewards and punishments associated with being able to effectively (or not) distinguish between and recognise people belonging to one's own "in-group" (i.e. own race faces).

As discussed in Section 1.8.1.1., two studies have demonstrated that the own-race bias should be considered in a wider social and political context (Chiroro & Valentine; 1995; Wright, Boyd and Tredoux; 2003). In countries where racial segregation and asymmetrical power relationships exist, the motivations to attend to black and white faces are very different. For example, within a South African society where a disproportionate amount of academics and people in power are white, there may be an increased incentive for black students to recognise other-race (i.e. white) faces, while the opposite may not be true. In line with this idea, Chiroro and Valentine (1995) and Wright, Boyd and Tredoux (2003) found that of the black and white students who attended multi-racial universities/colleges in Zimbabwe and South Africa respectively and thus had an opportunity for high daily inter-racial contact, only the black students exhibited a significantly reduced own-race bias. Thus the own-race bias arises not as a result of automatic categorization or perceptual expertise, rather it is a result of the attentional resources towards faces that we are motivated to distinguish between.

One of the earliest suggestions of this kind, and a theory on which the social categorization hypotheses were based, was put forward by Rodin (1987) who suggested that we are "attentional misers" when it comes to processing visual information. As such, we only assign attentional and cognitive resources to individuals who are deemed important or relevant to us in some way. Rodin suggested that we determine who merits this attention/cognitive effort according to our social purpose. She suggests that if a "disregard cue" is present, it serves as a signal to direct our attention elsewhere. What exactly

constitutes a disregard cue is not specified, however Rodin suggests that these cues may be based on broad categorical judgments, such as those of age, race or attractiveness. However she emphasized that these categorical cues are not necessarily in- or out- group categorizations, but that they are constantly evolving according to the observer's motivations and as such are entirely situation dependent. Those deemed unimportant to us are then cognitively disregarded, which essentially halts the processing of these individuals, rendering them practically invisible to us. In contrast, further attentional resources are allocated to those who we are motivated to "see", and as such individuating information is processed.

This type of theory does not depend on social groupings according to self-referential information, nor does it necessarily depend on the amount of contact one has with different groups of faces. Instead it focuses on the underlying motivations one may have to attend to certain groups of faces. If there is a suitable amount of motivation to attend to a face, then the cognitive resources will be made available to that face.

#### *1.8.2. The Own-Gender Bias in Face Recognition*

Another bias that has been discussed in the face recognition literature, albeit to a much lesser extent than the own-race bias, is that of the own-gender bias. For example, in a couple of studies using a forensic-style paradigm Shaw and Skolnick (1994, 1999) showed male and female participants videos of simulated crimes in which the perpetrator was either male or female. The authors found that the participants were generally more accurate at correctly identifying the culprit when they were of the same gender as themselves.

However, as previously discussed eyewitness paradigms, while ecologically valid, can be

problematic due to the small amount of data each participant contributes to the study and the potential problem of atypical exemplars being used as stimuli (see Section 1.7.1.).

Studies using more traditional old/new recognition paradigms have yielded more mixed results. While a meta-analysis of face recognition studies reporting both the gender of the participants and the gender of viewed faces found a significant own-gender bias in terms of correct identification measures, no such effect was found for false alarms (Shapiro & Penrod, 1986). In addition, while some studies have shown an own-gender bias in both male and female participants (e.g. Wright & Sladden, 2003), others have found it only to be present in females (e.g. Lewin & Herlitz, 2002; McKelvie, 1981; 1987) while others have found no evidence of a gender by face-gender interaction at all (e.g. Perfect and Moon, 2005). Thus the own-gender bias is a lot less reliable and robust in comparison to the own-race bias in face recognition.

#### *1.8.2.1. The Possible Mechanisms Underlying the Own-Gender Bias.*

Although the own-gender bias has received relatively little attention in the face recognition literature, at least one study has attempted to identify the possible mechanisms underlying this bias. Using an old/new paradigm with Tulving's (1985) remember/know distinction, Wright and Sladden (2003) asked participants to recognise both male and female faces, half of which were presented as whole faces and half of which had their hair removed. While the authors found a full cross-over own-gender bias, they also found that the removal of hair cues substantially impaired participant's ability to recognise own-gender faces (and other-gender faces, but to a lesser degree). Specifically, they found that memory for hair accounted for approximately half of the own-gender bias.

As the own-gender bias appears to be mediated by the differential usage of a single featural cue (hairstyle), it seems unlikely that a configural-expertise type explanation of this bias (like that so often given for the own-race bias) would be appropriate in this case. Indeed, such an explanation is difficult to justify, as an expertise hypothesis assumes greater experience with one gender over another, however males and females are equally prevalent in our society. And while it may be true that it is *quality* rather than *quantity* of experience that is important to develop such a bias, this too presents a problematic account of the own-gender bias. In fact, from an evolutionary stand-point one might be inclined to predict greater interest in and motivation to attend to faces of the opposite sex for mate selection purposes (thus a motivational account of this bias is also likely to fall short).

Instead, it seems that the own-gender bias can most readily be explained in terms of the differential feature processing (namely of hair cues) for own- and other- gender faces. Indeed studies investigating gender differences on person description tasks that rely heavily on featural aspects of appearance (as is the nature of verbal descriptions, see Section 1.2.1.) have found an own-gender bias, while a face recognition task with the same participants yielded no such effect (e.g. Shaw and Skolnick, 1994), supporting a featural-processing account of this bias.

Why differential featural-processing might best explain the own-gender bias in face recognition is unclear, although parallels could be drawn with Levin's (1996; 2000) race-feature processing model. This hypothesis suggests that the recognition deficit for other race faces occurs as a result of people automatically emphasising category-specifying features for out-group faces (e.g. skin tone in the case of race) to the detriment of



individuating information. It is possible that this explanation may also apply to the processing of own- and other- gender faces, with hairstyle serving as the salient gender cue.

## **1.9. Thesis Aims: Implications for the Own-Age Bias**

The over-arching aim of this thesis was to investigate the possible explanations for the own-age bias in face recognition. By referring to the own-race and own-gender bias literature, it has been established that there are a number of suggested mechanisms by which these biases may occur. Using these hypotheses as a starting point, the possible mechanisms responsible for producing the own-age bias will be investigated and evaluated.

However, before the possible reasons for the own-age bias in face recognition can be explored, one needs to establish that this bias does, in fact, exist. As described in Section 1.7. previous work in this area has been riddled with methodological problems, the most notable being the lack of successful matching of the ages of the facial stimuli with that of the participants. One area that has been particularly neglected is investigation of the ability of children and young adults to recognize faces that have been successfully matched to their age groups. As such, the first experimental chapter of this thesis aimed to establish whether or not an own-age bias exists in these two age groups.

### *1.9.1. The Contact Hypothesis and the Own Age Bias in Face Recognition*

The primary aim of this thesis was to investigate the role of contact in the own-age bias in face recognition (see Chapters 2-4). However, considering the role of exposure in this bias is not as straightforward as it is in the own-race bias literature and may be the

reason why this type of explanation has thus far gone relatively unexplored. Age is not a stable characteristic, unlike race. The age band to which we belong is constantly changing; one cannot dismiss the fact that, as adults, we were all once members of a different, younger age group with high exposure to faces belonging to that group. If the own age bias is due to cumulative, quantitative experience alone then one would expect children to show an exaggerated recognition advantage for own-age faces (which they are more familiar with as a result of schools comprising large numbers of similarly aged children) compared to faces belonging to older age groups (with which they have had relatively little experience). In contrast, one might expect adults who have had high levels of contact with both own and child age faces at various points throughout their lifetime, not to show any advantage for a particular age group (except those which they had not yet belonged to).

Initial research suggests that this may not be the case. As previously discussed, Anastasi & Rhodes (2005) showed that children exhibited an own-age bias of a similar magnitude to older adults. However, the methodological flaws associated with this, and similar studies (described in Section 1.7.) make it difficult to draw firm conclusions about the nature of the own-age bias across different age groups. It is of note, however, that in the only three studies that did successfully match the age of the stimuli used to the age of their participants, own-age biases were found for all age groups (Anastasi & Rhodes, 2006; Kuefner et al, 2008; Perfect & Moon, 2005). This suggests that contact, in terms of a cumulative measure of experience with age groups of faces, may not be responsible for the own-age bias.

However, as suggested in the own-race literature, it is possible that the index of contact that is important in the own-age bias is not one that is a quantitative cumulative

measure, rather it could refer to more recent contact with groups that are qualitatively more salient. If this were the case then one would expect to see an own-age bias in both child and adult populations, as most recent and socially important exposure is likely to be with faces of one's own age-group. In addition, if recent exposure is important in the own-age bias, then one would expect the size of this bias to be reduced or absent in people with high, recent exposure to other age groups (e.g. teachers). As such, Chapter 3 sought to establish whether recent, high quality exposure to other age groups had any effect on the magnitude of the own-age bias.

One factor that has yet to be mentioned, but should be noted within this thesis is to do with the role quality of contact may play in mediating the own-race bias. The idea that quality of contact may be important in this bias has been researched by those investigating attitudes and prejudices held for other-race faces. For example, Brigham (1993) found that negative attitudes towards other-races was significantly negatively correlated with levels of inter-racial group contact. Thus racial attitudes may play an indirect role in the mediation of the own-race bias. However, in terms of this thesis, it is unlikely that differential attitudes for own- and other-age will be as extreme as they are sometimes found to be in the own-race bias literature (e.g. Slone et al, 2000). As such, it is unclear how analogous these biases are really likely to be. However, investigating a face recognition bias that does not have strongly associated differential in-group/out-group attitudes is of great theoretical interest.

Admittedly this latter study design does not allow for the separation of (recent) quantitative and more qualitative aspects of exposure. As such, the fourth chapter aimed to

tease apart the different aspects of contact that may be important for producing, or reducing, the own age bias.

### *1.9.2. The Possible Mechanisms Underlying the Own-Age Bias in Face Recognition.*

The second main aim of this thesis was to use the own-race and own-gender bias literature as a platform from which to explore the possible mechanisms that might be responsible for the production of the own-age bias in face recognition. As discussed above, research into these biases essentially offer three possible types of explanation that could apply to the own-age bias. Specifically, these theories would predict that better own-age face recognition occurs as a result of one of (or a combination of) the following mechanisms:

1. Improved perceptual processing as a result of increased expertise, most likely characterised by enhanced configural processing for own-age faces (e.g. Rhodes et al, 1989)
2. The social categorisation of other-age faces as out-group members, possibly due to the presence of a category-specifying feature (e.g. Levin, 1996; 2000), resulting in the processing of this categorical information at the expense of individuating information
3. Increased motivation to attend to own-age faces as a result of social rewards and punishments (e.g. Rodin, 1987)

To date, as far as this author is aware, only three studies have specifically sought to investigate the possible underlying mechanisms responsible for producing the own-age bias in face recognition (deHeering and Rossion, 2008; Kuefner et al, 2008; Perfect & Moon,

2005). All three studies aimed to identify the role of perceptual expertise in this bias. For example, Perfect and Moon (2005) investigated whether the own-age bias was affected by inverting faces (see Section 1.2.2.). If the own-age bias is the result of increased expertise with own-age faces (and more efficient configural processing as a result of that expertise), then one would expect to see inversion affect own-age faces to a larger extent than other-age faces, resulting in the reduction (or even removal) of the own-age bias that is seen in upright faces. This, however, was not the case. Instead of inversion reducing the own-age bias, Perfect & Moon found that inverting the faces in fact did the opposite. As a result, the authors concluded that a social-categorisation account might offer a better explanation of the own-age bias (e.g. Levin, 1996; 2000), and as feature-based processing is less impaired by inversion (e.g. Leder & Bruce, 1998), a hypothesis that relies on the identification of a category-specifying feature might be better suited to explain this effect.

However, before one accepts this interpretation, it should be noted that a recent study has found a very different pattern of results. In another inversion study that specifically investigated expertise with own- and other- age faces in terms of inter-age contact levels, Kuefner et al (2008) found supporting evidence for the perceptual-expertise hypothesis. Using adults who either had low or high contact with other age faces (in this case children: i.e. participants were either undergraduate students or teachers respectively), the authors investigated participants' ability to recognise adult and children's faces, presented both in the upright and upside-down position. When the faces were upright, those in the low contact group performed with higher accuracy to own-age faces, while the high contact group were similarly accurate for both stimuli groups. The authors also found that inverting the faces produced a greater inversion effect for adult faces compared to child

faces in the low contact group, while the inversion cost was similar for both facial age groups for the high contact participants.

These results appear to support a perceptual expertise explanation of the own-age bias in face recognition, but as with most studies in this area, there are methodological problems. The main issue in this case was that the “own-age” stimuli (comprising photos of 20-30 year olds) were not matched with the age of the participants in the high contact group (who were 24-56 years old). As a result it is possible that the lack of “own-age bias” in this cohort is actually just a display of two “other-age” effects. Thus it is difficult to make claims about the role of contact and perceptual expertise in the own-age bias.

The final study of this kind was carried out by deHeering and Rossion (2008), who used the composite face effect (CFE; see Section 1.2.1) to investigate the role of perceptual expertise in the own-age bias. Again, the authors used pre-school teachers with experience of children’s faces to represent other-age face experts and compared them to similarly aged novices. Using a face matching task, the authors presented participants with pairs of child and adult composite faces (comprising different individuals in the top and bottom halves of the faces) and asked them to identify whether the individuals in the top halves of the faces were the same or different. Face halves were either presented aligned, or misaligned. In line with previous research on the CFE, participants performed more accurately when face halves were presented out of alignment with one another, suggesting holistic/configural processing of the perceptual whole face was interfering with the successful identification of its parts. However, in terms of accuracy, there was no three-way interaction between alignment, face age and group that would have been indicative of a perceptual-expertise account of the own-age bias. As the accuracy measure that was used in this study only

included “same” face decisions, this measure may not have been sufficient enough to truly represent perceptual ability. Failure to take into account performance on “different” face trials may have under- or over- represented group accuracy, as it fails to take into account discriminability or possible response biases.

The authors also investigated response time (again, only for same face pairs). As before, participants performed worse for aligned face halves. However, this time there was a significant three-way interaction with novices showing a much larger CFE for adults compared to children’s faces. That is, their performance was significantly more impaired by face-half alignment when faces were of the same age group to them compared to a different, younger age group. In contrast, experts showed no significant difference in the magnitude of their CFE for the two stimuli age groups. Perhaps even more compelling evidence for the role of expertise in the own-age bias was the finding that the magnitude of the experts’ CFE significantly correlated with the number of years experience they had working with children; with the CFE becoming larger for the children’s faces compared to adult faces after about 10 years of “other-age” experience.

This finding could potentially support a contact-type explanation of the own-age bias and specifically a perceptual-expertise account. However, yet again these authors failed to successfully match the ages of the facial stimuli to the participants. In fact, the age-bands of the two participants groups (novices: 27-35 years old; experts: 29-37) did not even overlap with the stimuli age-band (18-25 years of age). As such, it is difficult to make claims about the implications of this study in terms of an “own-age” bias.

Given the mixed findings and methodological problems with the three above-mentioned studies, it is still unclear whether a perceptual expertise account offers a suitable

explanation of the own-age bias, or whether a social categorisation account, or indeed a motivational account, may be more appropriate. Thus, this thesis sought to establish which of these three accounts might best explain the own-age bias in face recognition. Using paradigms that have previously been used in the own-race and own-gender bias literature to investigate these perceptual, social and motivational accounts, Chapters 4, 5 and 6 systematically explored these theories using successfully age-matched stimuli with a view to offering a suitable explanation for the own-age bias in face recognition.



## **Chapter 2**

### **2.1. Experiment 1: Introduction**

Previous research has suggested that young adults are better at recognising faces and make more accurate eyewitness identifications than older adults (e.g. Adams-Price, 1992; Searcy, Bartlett & Memon, 1999; Searcy, Bartlett, Memon, & Swanson, 2001; Yarmey, 1993). While it is known that cognitive performance deteriorates with age (see Hedden & Gabrieli, 2004 for a review), this apparent difference in facial memory performance might be partly due to the nature of the stimuli that are commonly used in face recognition studies. For example, most of the studies that have looked at face recognition performance of different age groups have compared undergraduates (or those of a similar age group) with older adults. However the targets and distractors used in these studies are usually faces of college age. It is therefore possible that younger adults' superior recognition accuracy is the result of some kind of own-age processing bias.

Relatively little research has been performed on this topic, but the few studies that have been carried out do appear to provide evidence for an own-age bias in face recognition. For example, Wright and Stroud (2002) presented young adults and middle-aged participants with videos of a crime in which the perpetrator was either similar or dissimilar in age to themselves. All participants were more likely to correctly identify the perpetrator from a line-up comprised of people belonging to their own age group. Further analysis showed that when the line-up comprised younger adults, the younger adults

showed superior recognition accuracy compared to the older adults, but age group difference disappeared when the line-up consisted of older adults.

Similar results were found using a paradigm investigating unconscious transference. Perfect and Harris (2003) found that younger adults were significantly more likely to correctly identify a young perpetrator than the older adults, however there was no difference between the two groups' performance when the "line-up" comprised older adult faces. In addition, the authors also found that older adults were more likely than younger adults to misidentify a bystander as the perpetrator of a crime when the line-ups consisted of younger adults, and again this difference was eliminated when the line-ups were comprised of older adults.

Both of these studies suggest that when viewing young faces, young adults out-perform older adults, but this difference is eliminated when the facial stimuli are photographs of older adults. However neither of these studies formally analysed the own-age bias as defined for the purpose of this thesis (a recognition advantage for own age faces over other age faces). Despite this, the accuracy scores reported in these studies (and seen on page 44) suggest that while older adults show an advantage for recognising own-age faces over other-age faces, younger adults do not. Obviously it is difficult to conclude this without undertaking the suitable statistical comparisons, and there is evidence that such a conclusion may not be justified. In a study similar to that of Wright and Stroud (2002), no effects or interactions were found for participant and/or face age, calling into question the reliability of these findings (Memon, Bartlett, Rose and Gray, 2003).

One possible reason for the conflicting results above may be the study designs that were used. While all three above-mentioned studies can be given merit due to their

ecological validity, the use of line-up procedures to measure face recognition can be problematic. The main problem with these forensic style paradigms is that each face-age category is only represented by a small number of faces (in all three studies only two faces were used for each age group) and thus findings can easily be skewed or biased by the unintentional inclusion of atypical exemplars. In order to minimise the possibility of this happening and to increase the power of the analyses, more traditional recognition memory paradigms following exposure to a large number of photographic facial stimuli have also been used to investigate the own-age bias.

One example of this is Perfect and Moon's (2005) study. They showed photographs of younger and older adults to two groups of similarly aged participants. The authors found a robust age x face-age interaction, characteristic of the own-age bias, with both age groups performing best with own-age faces. Anastasi and Rhodes (2006; Experiment 1) found a similar pattern of results with three adult groups: younger, middle-aged and older adults all exhibited superior recognition for own-age faces compared to other-age faces. However other studies have produced inconsistent results (see Table 2.1. for a summary of all adult own-age bias studies and their outcomes). For example some studies have found evidence of an own-age bias in younger, but not older adults when using younger and older adult faces as stimuli (e.g. Bartlett & Leslie, 1986; Fulton & Bartlett, 1991; Mason, 1986; Weise et al, 2008) while others have found the reverse to be true (Anastasi & Rhodes, 2006 Experiment 2). In addition, one study has found evidence of an own-age bias in young adults when viewing own-age and child faces (Kuefner et al, 2008).

Thus studies investigating the own-age bias in adults have produced varied results. However it is possible that this is due to poor matching of the participant age groups to the

Table 2.1 Summary of studies investigating the own-age bias in face recognition in adult participants

	Group	Mean Age of Participants	Age of "Own-Age" Faces (mean or age-range)	Are Ages Matched?	Is there an OAB?
<i>Studies with Adult Participants</i>					
Barlett & Leslie, 1986 (Exp 1)	Young Adults	18	20-39	✓	✓
	Older Adults	74	40-79	✗	✗
Barlett & Leslie, 1986 (Exp 2)	Young Adults	27.2	20-39	✓	✓
	Older Adults	66.5	40-79	✗	✗
Mason, 1986	Young Adults	17-29	20	✓	✓
	Older Adults	62-88	70	✗	✗
Bäckman, 1991	Young Adults	19-27	29.5	✓	✗
	Older Adults	63-70	76.2 (69-85)	✗	✓
	76 year olds	76	76.2 (69-85)	✗	✗
	85 year olds	85	76.2 (69-85)	✗	✗
Fulton & Bartlett, 1991	Young Adults	20-36	29.5	✓	✓
	Elderly	59-82	62.7	✗	✗
Wright & Stroud, 2002	Young Adults	18-25	21-23	✓	-
	Middle-aged Adults	35-55	48-51	✗	-
Memon et al, 2003	Young Adults	22.3	-	-	-
	Older Adults	69	-	-	-
Perfect & Harris, 2003	Young Adults	20.1	21	✓	-
	Older Adults	66.6	71	✓	-
Perfect & Moon, 2005	Young Adults	20.2	22.2	✓	✓
	Older Adults	73.9	73.4	✓	✓
Anastasi & Rhodes, 2006 (Exp 1)	Young Adults	18-25	18-25	✓	✓
	Middle-aged Adults	35-45	35-45	✓	✓
	Older Adults	55-78	55-75	✓	✓
Anastasi & Rhodes, 2006 (Exp 2)	Young Adults	18-25	18-25	✓	✗
	Older Adults	55-91	55-75	✗	✓
Kuefner et al, 2008 (Exp 2)	Young Adults	19-30	20-30	✓	✓
Weise et al, 2008	Young Adults	19-28	18-29	✓	✓
	Older Adults	61-76	55-82	✗	✗

- indicates information was not specified

ages of the facial stimuli used. While all of the studies claim to be studying an own-age bias in face recognition, only three of them successfully matched all of their facial stimuli ages to that of the participants: Anastasi and Rhodes (2006; Experiment 1), Kuefner et al (2008; Exp 2) and Perfect and Moon (2005). All three studies found a significant own-age bias for each age group tested. These findings suggest that adults are generally better at recognising faces belonging to their own age group than those belonging to another. However, it should be noted that one methodological shortcoming of Kuefner et al's study (2008, Exp 2) was that they failed to use alternative-pose photographs as their stimuli. As such, it is possible that their findings are reflective of participants' picture identification abilities (e.g. recognising an idiosyncratic feature in a picture) rather than their face recognition skills *per se* (Bruce, 1982).

So it may well be the case that older adults are not, in fact, worse at recognising faces than young adults, but are instead disadvantaged by the fact that most studies use young adult faces as their stimuli. Children are another group who may suffer from the same disadvantage. As discussed in Section 1.6., children are frequently cited as being poorer eyewitnesses and as being worse at recognising faces than young adults (e.g. Chance & Goldstein, 1984; Wells & Olson, 2003). However, again the majority of face recognition studies with children have used young adult faces as their stimuli (see Chung & Thomson, 1995 for review), presenting the possibility that their recognition abilities have been underestimated as a result of the fact that they are being asked to recognise "other-age" faces while young adults may have an own-age advantage.

Anastasi and Rhodes (2005) extended their work on the own-age bias in face recognition to include children and elderly adults and found a comparable own-age bias with both of these groups. This suggests that an own-age bias may be present in children as well as adults. However part of the procedure of these studies involved categorising the facial stimuli into their age groups at the learning stage. This may have actively drawn participants' attention to the ages of the faces and encouraged a related processing bias, so these findings should be interpreted with caution.

Two other studies have investigated the possibility of an own-age bias in children, with conflicting outcomes. Chung (1997) tested children and adults for their recognition of adult and child faces and found that while adults recognized adult faces more accurately than children's faces, no own-age bias was present for the child participants. However, in direct contrast, Crookes and McKone (2009) found the opposite pattern with children demonstrating superior recognition of child faces compared to adult faces, while adults exhibited no such bias. However, as with the adult studies, the latter two studies may not have successfully matched the participant ages to that of the facial stimuli used as the authors only broadly defined "own-age" to mean child versus adult. Thus, there is no clear pattern in the research that suggests whether or not an own-age bias truly exists in children, and indeed whether it exists in young adults when the "other age" of facial stimuli used is of child age. As such, the primary aim of this study was to clarify whether there is an own-age bias in children and young adults when faces belonging to the same, successfully matched age groups are viewed.

## **2.2. Method**

### *2.2.1. Design*

A mixed design was used, with age group as the between subjects variable (with two levels: children and undergraduates) and age of facial photograph as the repeated measures variable (again, with two levels: child – 8-10 years old and young adult – 18-25 years old). Measures of accuracy and reaction time (RTs) were taken for the dependent variables.

### *2.2.2. Participants*

There were 66 participants in total. The undergraduate group consisted of 23 females and 10 males (total mean age 20.09, SD 1.55, range 18-24 years) and the group of children comprised 17 females and 16 males (total mean age 8.76, SD .44, range 8-9 years). Undergraduate participants were all psychology students from the University of Sussex who received research credits for their participation. The children were all recruited from Year 4 at Goldstone Primary School in Hove after obtaining parental consent.

### *2.2.3. Materials*

Photographs of 64 Caucasian males were taken. Half were between 8-10 years old, and half were between 18-25 years old. Two photographs were taken of each individual, one in a smiling pose and the other neutral. This was done to ensure that participants were being tested on their face recognition abilities, and not their ability to recognise pictures (Bruce, 1982). All photographs were close up, frontal face images

without glasses, jewellery, facial hair or other identifying features. Each photograph was then converted to greyscale and edited to a standard size (300 x 350 pixels) using Adobe Photoshop software. The background of each picture and any information outside of the head outline and the contour of the chin were removed and made solid white (see Figure 2.1. for an example of the stimuli used).



**Figure 2.1** Examples of the facial stimuli used.

#### *2.2.4. Procedure*

For the initial learning phase participants were presented with 32 upright photographs (16 from each age group) in a random order at a 3 second rate, using Superlab 2.01 (Cedrus Corporation) on a desktop computer, with a viewing distance of approximately 45cm. The participants were instructed to try and remember the faces as best they could, as they would later be asked to identify them. Following the learning phase, participants completed a three minute filler task. This was the F-A-S verbal fluency task (Benton & Hamsher, 1977), where participants were given a minute per letter to name as many words as they could beginning with either F, A or S. This



particular task was chosen as it was thought to be appropriate for both age groups taking part in the study.

This was followed by the recognition test which consisted of 64 photographs, 32 of which had previously been seen in the learning phase in the alternate pose (targets) and 32 of which were new (distractors). Photographs appeared in a different random order for each participant and were counterbalanced with respect to pose and old/new status. Using the computer keyboard, participants were asked to indicate whether or not they recognized the individuals in the photos. A fixation dot was displayed in the centre of the screen for 500ms before each face appeared. The photographs appeared individually and the rate of presentation was determined by the participant's speed of response, with each face remaining on the screen until a response was made or after 2500ms had elapsed.

## **2.3. Results**

### *2.3.1. Accuracy*

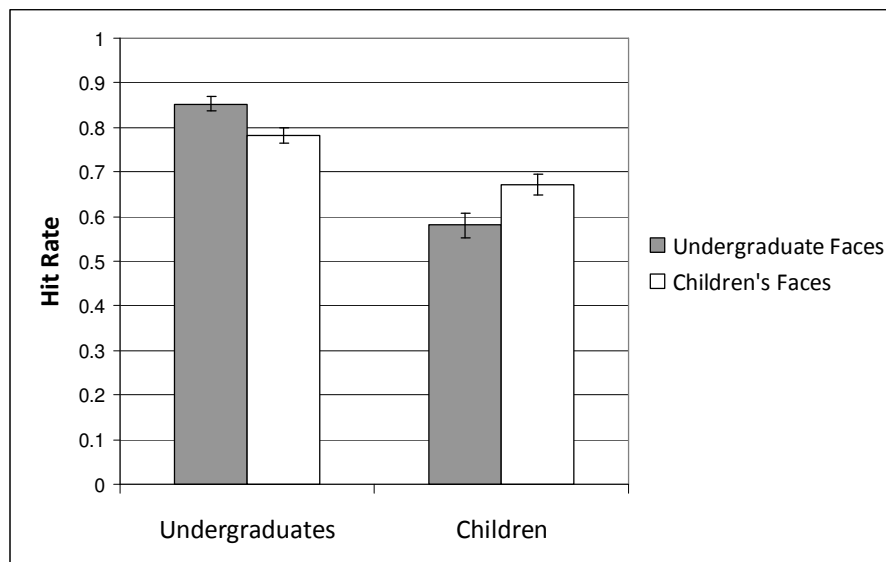
Hit rates (proportion of correctly detected targets), false alarm rates (proportion of mistakenly identified distractors) and a combination of these measures (d-prime scores ( $d'$ )) were calculated to investigate accuracy. Estimates of  $d'$  were used for analysis, rather than the percentage of correct responses, as  $d'$  is thought to be a better index of recognition discriminability. D-prime is a parametric test statistic that is used to determine how accurate participants are at making binary decisions about test stimuli. The formula for  $d'$  considers both the proportion of responses on which participants report a target stimulus as being present when it is present (hits), and the proportion of

responses that participants report a test stimulus as being present when it is absent (false alarms). A  $d'$  score of 0 indicates chance performance and the higher the score, the more accurate the performance.

In calculating  $d'$ , a flattening constant was used so that  $z$  scores could be calculated when the hit or false alarm rate was either 0 or 1. In order to do this, Wright and Sladden's (2003) procedure was used. Hit rates (HR) and false alarm rates (FAR) were calculated for each person for both face-age groups, by adding 0.5 to their total amount of hits (or false alarms), and then dividing the total by the number of trials they could have got correct (the sum of hits and misses for HR; the total false alarms and correct rejections for FAR) plus 1. Since there was no effect of pose type on accuracy, data were collapsed across this variable for the purpose of analysis.

### 2.3.2. Hit Rates

Figure 2.2. shows the mean proportion of hits for both experimental groups for both face age conditions.



**Figure 2.2** The effect of face age on the mean proportion of correctly detected targets made by the different contact groups (error bars show mean  $\pm 1$  standard error)

A two-way mixed analysis of variance (ANOVA) (two levels of group x two levels of face age) revealed that there was no overall significant main effect of face age ( $F < 1$ ) on the proportion of hits made. However, there was a significant main effect of age group ( $F(1,64) = 57.60$ ,  $p < .001$ ,  $\eta_p^2 = .47$ ), with undergraduates detecting more targets (mean = .82, .10) than children (mean = .63, .16). In addition to this, there was also a significant interaction between face age and age group ( $F(1,64) = 20.13$ ,  $p < .001$ ,  $\eta_p^2 = .24$ ) such that the undergraduates produced more hits for the young adult faces (mean = .85, .09) than the children's faces (mean = .78, .10), while children showed the opposite pattern, scoring more hits on children's faces (mean = .67, .14) than young adult faces (mean = .58, .17).

This significant interaction was examined further, using follow-up Bonferroni corrected paired t-tests<sup>4</sup>. These demonstrated a significant effect of face age for both the children ( $t(32) = -3.06$ ,  $p < .01$ ,  $d = -.58$ ) and the undergraduates ( $t(32) = 3.37$ ,  $p = .001$ ,  $d = .74$ ), thus showing an own-age bias for both groups in terms of hit rates. Further independent t-tests (with Bonferroni correction) revealed that undergraduates performed significantly better than children for both children's faces, ( $t(64) = -3.68$ ,  $p = .001$ ,  $d = -.92$ ) and young adults' faces ( $t(48.06) = -8.42$ ,  $p < .001$ ,  $d = -2.11$ ).

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<sup>4</sup> All follow-up t-tests in this chapter are 1-tailed tests due to the directional hypotheses associated with the own-age bias.

### 2.3.3. False Alarms

Figure 2.3. shows the mean proportion of false alarms for both experimental groups for both face age conditions.

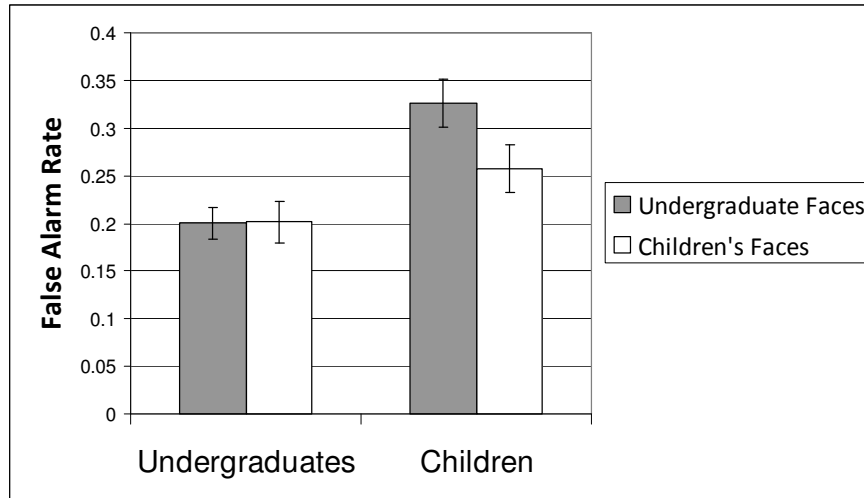
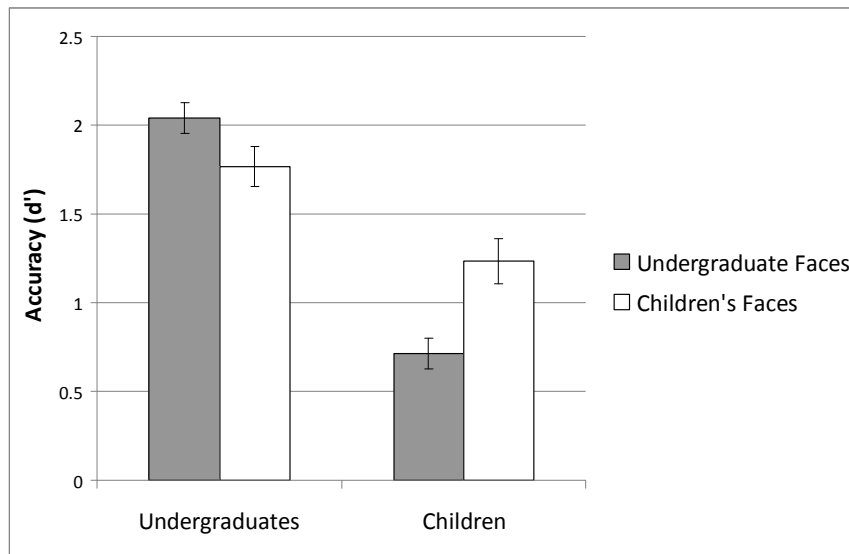


Figure 2.3 The effect of face age on the mean proportion of false alarms made by the different contact groups (error bars show mean  $\pm$  1 standard error)

A two-way mixed ANOVA (two levels of group x two levels of face age) revealed a significant main effect of age group ( $F(1,64)=12.98, p=.001, \eta_p^2 = .17$ ) on the proportion of false alarms made, with undergraduates wrongly identifying significantly fewer distractor faces as having been seen before (means = .20, .11) than did children (mean = .29, .15). No significant main effect of face age ( $F(1,64)=3.11, p=.08$ ) was found, nor was there a significant interaction between face age and age group ( $F(1,64)=3.38, p=.07$ ).

### 2.3.4. D-prime

Figure 2.4. shows the mean  $d'$  score for both experimental groups for the two stimulus conditions. Both groups appear to have been able to identify whether a face was familiar or not across all conditions at above chance levels ( $d' > 0$ ).



**Figure 2.4** The effect of face age on mean d-prime accuracy scores for the different contact groups (error bars show mean  $\pm$  1 standard error)

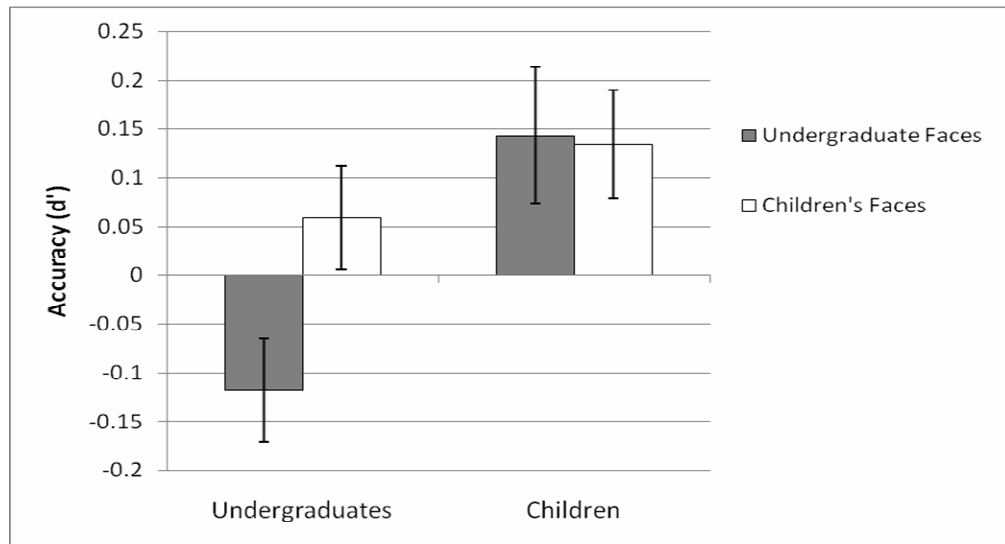
A two-way mixed ANOVA (two levels of group x two levels of face age) revealed that there was no overall significant main effect of face age ( $F(1,64)=2.22$ ,  $p=.14$ ,  $\eta_p^2=.03$ ) on  $d'$  scores. However, there was a significant main effect of age group ( $F(1,64)=56.21$ ,  $p<.001$ ,  $\eta_p^2=.47$ ), with children performing significantly less accurately (mean = .97, .67) than the undergraduates (mean = 1.90, .60) overall. This finding was further qualified by a significant interaction between face age and participant age-group ( $F(1,66)=22.86$ ,  $p<.001$ ,  $\eta_p^2=.47$ ) such that children performed more accurately with children's faces (mean = 1.23, .73) than with the young adult faces (mean = .71, .49), while undergraduates showed the opposite pattern (child face mean = 1.77, .66, young adult face mean = 2.04, .51). These results are consistent with an own-age bias in face recognition, as both groups performed more accurately with faces of their own age group.

This pattern of results was further examined using follow-up Bonferroni corrected paired t-tests which demonstrated a significant effect of face age for both the

children ( $t(32) = -5.01, p < .001, d = -.84$ ) and the undergraduates ( $t(32) = 2.11, p < .05, d = .46$ ), showing an own-age bias for both groups in terms of accuracy. Further independent t-tests with Bonferroni corrections revealed that undergraduates performed significantly better than children with both children's faces, ( $t(64) = -3.13, p < .01, d = -.78$ ) and young adults' faces ( $t(64) = -10.77, p < .001, d = -2.69$ ).

### 2.3.5. *C Response Bias*

Estimates of  $c$  were analysed to investigate the strategies that participants were using for the different face types, for example how likely a participant was to respond “yes” when asked if they recognised a face. A participant who always responds “no” to a face will never make a false alarm error, but will have a hit rate of 0; on the other hand a participant who always responds “yes” to a face is guaranteed a 100% hit rate. Like  $d'$ , this parameter is based on false alarm and hit rates. The ideal participant would not show a response bias and would have a  $c$  score of 0. A participant who tends to respond liberally with “yes” would have a negative  $c$  score, whereas a participant who may favour a more conservative approach, tending to respond with “no”, would have a positive score. Like  $d'$ , response bias is based on false alarm and hit rate. Figure 2.5. shows the mean  $c$  score for both experimental groups for the two face age stimulus conditions.



**Figure 2.5** The effect of face age on c response bias scores for the different contact groups (error bars show mean  $\pm 1$  standard error)

A 2x2 mixed ANOVA showed that there was a significant main effect of age group ( $F(1,64)=7.21, p<.01, \eta_p^2=.10$ ) with undergraduates performing generally more liberally (mean = -.03, .32) than children (mean = .14, .36). No significant main effect of face age ( $F(1,64)=2.15, p=.15, \eta_p^2=.03$ ) was found, nor was there a significant interaction between face age and participant age-group ( $F(1,64)=2.72, p=.10, \eta_p^2=.04$ ).

The results show that undergraduates have a more conservative response bias than children. It is unclear why a conservative strategy might have been employed by the undergraduates (particularly for undergraduate faces), while a more liberal strategy was adopted by the children. However, it is of note that while differences in response bias patterns were found, none of the mean values falls outside  $c = \pm 0.15$  indicating that the magnitude of these biases is extremely small and may, therefore, not be all that meaningful.

### 2.3.6. Latency

To minimize the variability often found in reaction time (RT) data, each individual's performance was examined for every trial. Any RTs longer than the individual's mean  $\pm 2.5$  standard deviations were replaced by that participant's mean RT (a method advocated by Ratcliff, 1993). 2.1% of the children's responses and 2.3% of the undergraduate's responses were replaced in this way. Corrected mean RTs are shown in Figure 2.6.

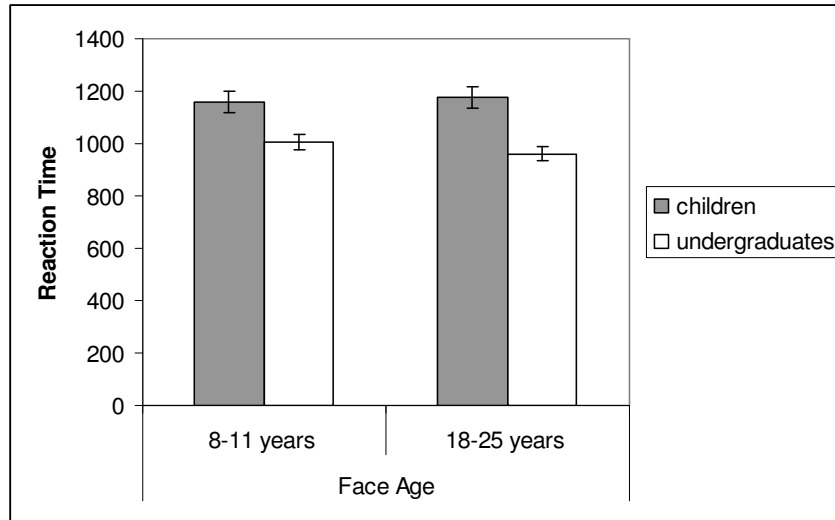


Figure 2.6 Mean reaction times for correct responses for the different face age stimuli for both age groups (bars show mean  $\pm 1$  standard error).

Mean RTs for correct responses were entered into a mixed 2 x 2 ANOVA with group and face age as variables of interest. This revealed no significant main effect of face age ( $F(1,64)=2.35, p=.13$ ), however there was a significant main effect of age group ( $F(1,64)=14.07, p<.001, \eta_p^2=.18$ ), with undergraduates (mean = 984.42, 160.22) performing faster than children (mean = 1169.23, 238.96) overall. A significant interaction between these two variables was also found ( $F(1,64)=10.10, p<.01, \eta_p^2=.14$ ), with children performing faster with children's faces (mean = 1161.02, 239.93) than



with the young adult faces (mean = 1177.45, 241.42), while undergraduates showed the opposite pattern (child face mean = 1007.93, 168.63; young adult face mean = 960.90, 150.21). These results are consistent with an own-age bias in face recognition, as both groups performed faster when correctly responding to faces of their own age group.

Bonferroni corrected paired t-tests revealed a significant effect of face age for undergraduates ( $t(32)=-3.69$ ,  $p=.001$ ,  $d=-.29$ ), but not for children ( $t(32)=1.07$ ,  $p=.29$ ,  $d=.07$ ). Further independent t-tests revealed that undergraduates performed faster than children for both age groups of faces (children's faces, ( $t(64)=3.00$ ,  $p<.01$ ,  $d=.75$ ; young adult faces  $t(64)=4.38$ ,  $p<.001$ ,  $d=1.10$ ).

These results suggest that in terms of reaction time data, while undergraduates show significant differences in their performance for the different facial stimuli, exhibiting an advantage for own-age faces, the same cannot be said for children who respond at similar speeds to both face age conditions. This result is not exactly unexpected. While carrying out the study, it was noted that the younger age group did not put as much effort and concentration into their performance as the older age group, typically talking and fidgeting throughout the experiment. It is also unclear how representative the children's response times are of the cognitive processes involved in this recognition task. It is likely that there were time lags and inconsistencies between when a child made a decision about the familiarity of a face and when they made the appropriate motor response. This is believed to be an issue, because the children often verbally identified the faces as familiar or not before pressing the corresponding button. These observations indicate that perhaps reaction times are not the best measure of recognition performance for children.

### 2.3. Discussion

Previous research has suggested that adults are better at recognising faces of their own age group than those of a different age (e.g. Anastasi & Rhodes, 2006; Perfect & Moon, 2005), however whether children also show this own-age bias remains unclear. The three studies that had previously been employed to investigate this issue contained methodological flaws that make interpretation of the findings difficult. For example, while claiming to investigate an “own-age” bias in face recognition, Crookes and McKone (2009) failed to successfully match the participant ages to that of the facial stimuli used, themselves acknowledging that that they “only defined ‘own-age’ broadly to simply mean child versus adult status, rather than attempting to match exact age[s]”. In addition, Chung (1997) provided no information about the ages of the facial stimuli they used, nor the age of their “adult” participants. As such, stating that these studies were truly investigating an *own-age* bias in face recognition may not have been entirely appropriate.

While Anastasi & Rhodes (2005) did successfully match their child participants and facial stimuli in terms of ages, their methodology presented a problem. When encoding the facial stimuli, participants were asked to categorise each photo into its appropriate age band. This encoding task may have induced an artificial “in-group” processing bias (e.g. Sporer, 2001) by drawing the participants’ attention to the age of the photographs and therefore may not be representative of the participants’ normal face recognition abilities.

In order to address these issues the present study aimed to investigate the own-age bias in face recognition for children and young adults by successfully matching the

ages of the participants with those of the facial stimuli. As with previous studies a traditional old/new recognition paradigm was used, as it offers better statistical power than forensic-style eyewitness testimony paradigms. However in contrast to Anastasi and Rhodes' (2005) study, participants were not told that they would be viewing faces of different ages, and they were not asked to classify faces in the initial learning phase.

Accounting for these former methodological problems, the results obtained from this study were nevertheless consistent with those of Anastasi and Rhodes (2005). Both children and young adults exhibited an own-age bias in face recognition, as they both exhibited superior accuracy when recognising own-age faces. And while children were found to perform worse than adults overall, the presence of an own-age bias in this cohort indicates that previously cited age-related deficits in children's face recognition abilities may, at least to some extent, be exaggerated.

This enhanced ability to discriminate own-age faces is a similar pattern to that observed for the well documented own-race bias, where participants are better at recognising faces belonging to their own race, than those of another race (see Brigham, Bennett, Meissner & Mitchell, 2007 for a recent review). As such, previous studies investigating the own-age bias have suggested that the two biases in face recognition may be analogous (e.g. Wright & Stroud, 2002). If this is the case, then we may be able to gain some insight into the mechanisms responsible for the own-age bias by consulting the plethora of literature investigating the own-race bias.

The most popular explanation of the own-race bias proposes that our ability to recognise faces of a particular race is mediated by the amount of contact we have with members of that race (e.g. Brigham & Malpass, 1985). As we tend to spend more time with members of our own racial group, and are therefore more familiar with members of

this group, we have better memory and recognition for own-race faces<sup>5</sup>. With a slight adjustment this theory could easily be applied to explain the results of the current study. It is possible that the own-age bias seen here is the result of increased exposure to (and more familiarity with) individuals belonging to the same age group as the participants. Both age groups were recruited from settings where participants would have been subject to high levels of daily contact with members of their own age group: children were recruited from schools and adults were university students.

However, while this contact-type explanation of the own-age bias is intuitively appealing, it cannot be accepted without one obvious caveat. Studies which have investigated the role of contact in the own-race bias have, more often than not, taken cumulative, quantitative metrics to estimate contact levels (see Meissner & Brigham, 2001 for a review). This method may not be entirely appropriate when considering the own-age bias, namely due to the fact that the older age group has previously belonged to other, younger age groups. As such, throughout their lifetime they should have acquired enough experience with faces of younger age groups that these faces should be suitably familiar to them, allowing them to recognise them at levels similar to own-age faces. Given that the young adults in this study exhibited better recognition of own-age faces than children's faces, this does not appear to be the case. Thus, the contact hypothesis as it stands struggles to satisfactorily account for the own-age bias. If however we suggest that it is only *recent* exposure to faces that is important, then the contact hypothesis can be saved (this is discussed further in the next chapter).

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<sup>5</sup> As a "high-level" theory the contact hypothesis does not specifically allude to the underlying mechanisms through which contact might exert its influence, however this issue is addressed further in Chapter 3.

It may be also be of note that these findings present a slightly different pattern of results to that usually seen in studies on the own-race bias. Concentrating on studies which used signal detection measures ( $d'$  and  $A'$ ), Meissner & Brigham's (2001) meta-analysis of the own-race bias found a robust cross-race effect. Breaking the effect down into its constituent hit and false alarm rates showed that this pattern was due to own-race faces being correctly identified 1.40 times more than other-race faces, while other-race faces were 1.56 time more likely to be misidentified than own-race faces. In addition, the authors found that participants tended to use a significantly more conservative response criterion when recognising own- compared to other- race faces. In contrast, while the current study found a significant own-age bias in terms of both discriminability and hit rates similar to that seen in the own-race bias literature, no such effects were found for either false alarm rates or response criterion. These findings suggest that while the own-race bias literature is a good starting point for investigating the own-age bias, the two biases may not truly be analogous phenomena.

The current study found an own-age bias in both young adults and children for successfully age-matched facial stimuli. While the data from the current study do not allow us to identify the specific underlying mechanisms that may be responsible for this effect, it is possible that a contact-type explanation may be appropriate. This will be further investigated in the next chapter. But regardless of the drivers of this effect, the pattern of results obtained in this study does have significant practical implications in terms of eyewitness testimony. As Wright and Stroud (2002) note, most studies investigating the eyewitness identification abilities of different age groups have largely ignored the age of the perpetrator as an influential factor. However the current study suggests that individuals may be worse at identifying a suspect/unfamiliar face when

they are of a different age to the perceiver. As such, the age of the witness *and* the age of the perpetrator (and particularly the interaction between these variables) may be important factors to consider when trying to assess how well an individual is likely to perform when recognising previously seen unfamiliar faces.

## Chapter 3

### 3.1. Experiment 2: Introduction

As discussed in the previous chapter, previous research has identified the existence of an own-age bias in face recognition (e.g. Wright & Stroud, 2002) and this has been found in children, young and older adults (e.g. Anastasi & Rhodes, 2005; 2006). However, while a number of studies have shown this bias to exist, little is known about its exact nature and the underlying mechanisms that produce it. In order to try and establish possible reasons for the existence of an own-age bias, it may be useful to consider the wealth of existing research on the own-race bias<sup>6</sup>. It is well documented that people are more accurate at recognising faces of their own race than those of a different, less familiar race (see Section 1.8.1. for an in depth discussion of this phenomenon; Meissner & Brigham, 2001 for a review).

While an all-encompassing, generally accepted theory for the own-race bias does not yet exist, perhaps the most popular explanation for it is the “contact hypothesis”. This high-level theory proposes that people become experts at differentiating between faces of their own race due to increased contact with members of their own race compared to those of other races (e.g. Brigham & Malpass, 1985; Chiroro & Valentine, 1995). This account of the own-race bias has been supported by a number of studies showing that there is a significant positive relationship between

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<sup>6</sup> The own-age and own-race biases may or may not be analogous phenomena, but the theories put forward to explain the own-race bias make a useful starting-point for this type of research.

memory for faces of individuals from a certain race and the amount of contact the participant has had with that race (e.g. Slone, Brigham & Meissner, 2000; Wright, Boyd & Tredoux, 2003). Meissner & Brigham's (2001) meta-analysis also found a significant, though small (accounting for approximately 2% of the variability in the data) relationship between other-race discrimination and self-report measures of inter-racial contact. However, it remains unclear precisely what aspect of contact is important for the development of an own-race bias to occur.

One class of explanation proposes that increased contact with a race (usually our own) somehow produces improved perceptual processing for that particular facial group in some way. For example, Rhodes, Tan, Brake, and Taylor (1989) suggested that exposure to own-race faces enhances our ability to appropriately extract the configural information which is at the heart of expert face recognition (Diamond & Carey, 1986). This *configural-expertise* explanation of the contact hypothesis appears to be supported in both behavioural and neurological domains. Evidence using inverted (Rhodes et. al., 1989), part-whole (Tanaka, Kiefer & Bukach, 2004) and composite (Michel, Rossion, Han, Chung & Caldara, 2006) faces suggests that other-race faces are processed less configurally or holistically (and hence perhaps less efficiently) than own-race faces. Differential activation of the Fusiform Face Area for same- and other-race faces is also consistent with this claim (Golby, Gabrieli, Chiao, & Eberhardt, 2001).

Another account based on perceptual processing is Valentine's (1991) multi-dimensional face space model. This suggests that faces are represented as points in a multidimensional space, whose dimensions consist of the facial characteristics that would best serve to discriminate between faces. It is thought that the dimensions develop in accordance with the individual's experience of faces. The theory explains



the own-race bias by suggesting that a lack of exposure to other-race faces means that the dimensions necessary for individuating them are less well represented than those needed to distinguish between own-race faces. Both of these theories assume that perceptual face processing mechanisms become better tuned for the types of faces with which we have a greater amount of experience.

An alternative, although not mutually exclusive, class of explanation for the own-race bias focuses more on the social psychology of person recognition. These theories suggest that we automatically categorize faces according to whether or not they belong to our own in-group (e.g. our own race), and that it is this process of categorization that has consequences for how we subsequently process those faces (e.g. Levin, 1996, 2000; Sporer, 2001). For example, Sporer's (2001) In-group/Out-group Model (IoM) suggests that in-group faces are encoded in an automatic, configural manner (typical of expert face processing), while out-group faces automatically trigger a categorisation of that person as belonging to an "out-group". This categorisation in turn leads to the faces being cognitively discounted (or even disregarded), resulting in a reduced, less efficient processing strategy and associated recognition deficits. "Contact" has a role to play in this process only insofar as it might lead to the development of in-group and out-group relationships<sup>7</sup>. This type of explanation could clearly be extended to explain recognition deficits for out-groups other than race, such as age and gender.

Yet another possibility is that contact *per se* does not affect face processing directly; instead, contact may *reflect* or *drive* the degree of interest a person has in faces

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<sup>7</sup> Note that the *quality* of contact, rather than merely the *amount* of contact, might be the important variable here: see Wright, Boyd and Tredoux (2003) for a demonstration of this in the context of the own-race bias.

of a particular kind and the resultant amount of attention allocated to them. It is this interest/attention that may be the important factor in determining how expert we are at processing faces of a particular category (e.g. own-age faces), and may depend on the incentives for doing so (e.g. social rewards or punishments). This theory is admittedly speculative; however, Wright, Boyd and Tredoux (2003) found that although white and black university students had similar opportunities for experience with the alternate race, only the white students showed an own-race bias. Perhaps, due to the asymmetrical power relationships within South African society, the black students had an incentive for trying to recognise white faces, while the opposite was not true.

Since this current study was carried out in 2006, two other studies investigating the role of contact in the own-age bias have been carried out. Both Kuefner et al (2008) and deHeering and Rossion (2008) investigated the ability of adults who had either low or high contact with children (i.e. they were either undergraduate students or teachers respectively) to recognise adult and children's faces. Using an inversion paradigm (a manipulation known to disrupt configural processing, the hallmark of expert face processing, e.g. Diamond & Carey 1986; see Section 1.2. for further discussion of this), Kuefner et al (2008) found that low contact participants were more affected by inversion of own-age faces than children's faces, while high contact participants showed no such difference. In addition, they found an own-age bias present for upright faces only with the low contact participants, apparently supporting a contact-type explanation of the own-age bias based on perceptual expertise. deHeering and Rossion's (2008) study of the composite face effect (another effect that taps into configural processing, see Section 1.2.1.) appears to further support this claim. They found that while the low contact participants showed a much larger composite effect for adult compared to

children's faces, no difference was found for the high contact group. In addition, these authors found that the size of the high contact participants' composite face effect was modulated by the amount of time the participants had been working with children, and therefore the amount of experience they had with these other-age faces.

While these two studies initially appear to support a contact-type explanation of the own-age bias (and specifically a perceptual-expertise account), neither study successfully matched the ages of the facial stimuli to the high contact participants (or to the low contact participants in the latter study). As a result, it is possible that the lack of differences found between the recognition of "own-age" and "other-age" stimuli in the high contact groups are actually just a result of participants viewing two groups of "other-age" stimuli. Considering this, it is difficult to make claims about the implications of either of these studies in terms of an "own-age" bias. As such, it is still unclear whether either contact or perceptual expertise (or both) play an important role in this phenomenon.

The present study investigated the role of contact in the context of the own-age bias. Two groups were compared in terms of their ability to recognise children's faces and faces of their own age: trainee teachers, who had high occupational exposure to primary school children together with a strong interest in them; and similarly-aged controls, who had little exposure to children (or interest in them). By analogy with the explanations proposed for the own-race bias, we can make several competing predictions:

1. "Improved perceptual processing" explanations (e.g. Valentine 1991, Rhodes et al 1989) might predict that teachers and controls will perform similarly with both children's faces and adult faces. During their own development, both groups should

presumably have had sufficient experience to become "face experts" with children's and adult's faces alike. Note that this prediction would only be true if one assumes that exposure to a certain class of face has enduring effects. If *recent* exposure to faces carries more weight than past experience, then "perceptual expertise" explanations would predict that the controls should perform as well as the trainee teachers with adult faces, but the teachers should perform better than the controls with children's faces. I shall return to this point in the discussion.

2. "Social categorisation" explanations (e.g. Levin, 1996, 2000; Sporer, 2001) predict that teachers and controls will be similar in performance, however in this case both groups should show better recognition for own-age faces. This is because the two groups of participants are the same age and children should constitute an "out-group" in both cases.

3. A third explanation is in terms of motivation to attend to faces (e.g. Wright, Boyd & Tredoux 2003). This would predict that teachers and controls will be similar in performance with adult faces, but *not* with children's faces: because of trainee teachers' increased interest in, and attention to, children, they should be better than controls at recognising children's faces.

## **3.2. Method**

### *3.2.1. Design*

A mixed design was used, with one between subjects variable: group (two levels: trainee teachers and controls) and one repeated measures variable: age of

photograph (two levels: child – 8-11 years old and own age – 19-30 years old).

Measures of latency and accuracy ( $d'$ ) were calculated.

### 3.2.2. *Participants*

There were 66 participants in total: 33 in the trainee teacher group (mean age 24.21, SD 2.46, range 21-30 years) and 33 controls (mean age 22.94, SD 2.94, range 19-30 years). To ensure that contact was successfully operationalised into high- and low-contact groups, the amount of occupational contact of participants with 8-11 year-old children since leaving school was recorded. Controls had no contact of this type. Trainee teachers had a mean contact score of 16.50 months (SD=17.05).

All participants were University of Sussex students, either undergraduates, postgraduates or trainee teachers (students on a Postgraduate Certificate of Education course). Sixty eight participants originally took part in the study, however the data from one of the trainee teachers and one of the controls were excluded as one failed to follow the instructions and the other performed at chance.

### 3.2.3. *Materials*

Digital photographs were taken of 64 Caucasian males. Half were between 8-11 years old, and half were between 19-30 years old. Two photographs were taken of each individual, one smiling and the other neutral. All photographs were close up, frontal face images without glasses, jewellery, facial hair or other identifying features. Using Adobe Photoshop, each photograph was converted to greyscale and resized to 300 x 350 pixels. As in experiment one, the picture's background and any information outside the external face outline was removed (see Fig.2.1 on page 91 for an example of this).

To ensure that the faces belonging to both age groups were similarly distinctive, 18 volunteers (aged 18-30 years old) rated each face on a 5 point scale (1 = “extremely distinctive”, 5 = “not at all distinctive”). There was no significant difference in the distinctiveness ratings for the two groups of faces, paired samples  $t(17) = .23$ ,  $p = .82$ ,  $d = .05$ .

#### 3.2.4. Procedure

For the initial learning phase participants were presented with 32 photographs (16 from each age group) in a random order at a 3 second rate, using Superlab 2.01. A fixation cross was displayed in the centre of the screen for 500ms before each face appeared. The participants were instructed to try and remember the faces as best they could, as they would later be asked to identify them. Following the learning phase, participants completed a 3-minute filler task which consisted of the F-A-S verbal fluency task (where participants are given a minute per letter to name as many words as they can that begin with either F, A or S).

This was followed by the recognition test which consisted of 64 photographs, 32 of which had previously been seen in the alternative pose during the learning phase, and 32 of which were new. Photographs were counterbalanced with respect to pose and old/new status and appeared in a different random order for each participant. Using the computer keyboard, participants were asked to indicate whether or not they recognized the individuals in the photos. A fixation cross was displayed in the centre of the screen for 500ms before each face appeared. The photographs appeared individually at a presentation rate that was determined by the participant’s speed of response. Each face remained on the screen until either a response was made or for a maximum of 2500ms.

### 3.3. Results

Since there was no effect of pose type on either accuracy or reaction time, data were collapsed across this variable for the purpose of analysis.

#### 3.3.1. Accuracy

Estimates of  $d'$  were used for analysis, rather than the percentage of correct responses:  $d'$  is a better index of recognition discriminability since it takes into account false alarms (false recognition of distractor faces). Table 3.1. shows hit rates (correct identification of target faces) and false alarm rates. In calculating  $d'$ , a flattening constant was used (as in Wright & Sladden, 2003) so that  $z$  scores could be calculated when the hit or false alarm rate was either 0 or 1.

Figure 3.1. shows the mean  $d'$  score for both experimental groups for the stimulus conditions (children and own age photos). Both groups performed at above chance levels ( $d' > 0$ ) throughout.

**Table 3.1 Mean proportion of hits and false alarms,  $d'$  accuracy and response bias ( $c$ ) scores**

Participant Group	Photograph Age	Hit Rate		False Alarm Rate		Accuracy ( $d'$ )		Response Bias ( $c$ )	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Controls	Own Age	0.85	0.10	0.16	0.10	2.27	0.64	0.00	0.37
	Children	0.78	0.11	0.16	0.11	1.95	0.64	-0.14	0.32
Trainee Teachers	Own Age	0.82	0.12	0.14	0.07	2.17	0.73	-0.04	0.28
	Children	0.85	0.09	0.13	0.08	2.35	0.61	-0.03	0.30

Figure 3.1 Mean accuracy scores and reaction times for both groups for the different facial stimuli (bars show mean  $\pm 1$  standard error)



A two-way mixed ANOVA (two levels of group x two levels of face age) revealed that while there was no significant main effect of group ( $F(1,64)=1.24, p=.27, \eta_p^2=.02$ ) or face age ( $F(1,64)=.57, p=.45, \eta_p^2=.01$ ), there was a significant interaction between these two variables ( $F(1,64)=7.70, p<.01, \eta_p^2=.11$ ), indicative of an own-age bias.



Bonferroni corrected follow-up paired t-tests<sup>8</sup> demonstrated a nominally significant effect of face age for the controls ( $t(32) = 2.04, p < .05, d = .50$ ), however this finding did not survive the Bonferroni corrected alpha level ( $\alpha = .025$ ). The trainee teachers showed no effect of face age ( $t(32) = -2.00, p = .05, d = .27$ ). Further independent t-tests with Bonferroni correction revealed that trainee teachers were significantly more accurate than controls for children's faces, ( $t(64) = 2.59, p < .01, d = .64$ ) while the two groups performed similarly with faces of their own age ( $t(64) = -.62, p = .54, d = -.15$ ).

### 3.3.2. Latency

To minimize the variability often found in reaction time (RT) data, each individual's performance was examined for every trial. Any RTs longer than the individual's mean  $\pm 2.5$  standard deviations were replaced by that participant's mean RT (Ratcliff, 1993). 2.2% of the values for the trainee teachers and 2.4% for the control group were replaced in this way. Corrected mean RTs are shown in Figure 3.1.

Mean RTs for correct responses were entered into a mixed 2 x 2 ANOVA with group and face age as variables of interest. This revealed no significant main effect of group ( $F(1,64) = 1.61, p = .21, \eta_p^2 = .02$ ) or face age ( $F(1,64) = .05, p = .83, \eta_p^2 < .01$ ), but there was a significant interaction between these two variables ( $F(1,64) = 39.44, p < .001, \eta_p^2 = .38$ ), indicative of an own-age bias.

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<sup>8</sup> All t-tests reported in the results section are two-tailed tests due to unknown influence of contact on the direction of a face-age recognition bias.

Bonferroni corrected paired t-tests revealed a significant effect of face age for both experimental groups (trainee teachers:  $t(32)=4.29$ ,  $p<.001$ ,  $d=.50$ ; controls:  $t(32)=-4.64$ ,  $p<.001$ ;  $d=-.28$ ): controls reacted faster for own-age faces, whereas trainee teachers responded faster to children's faces. Curiously, further independent t-tests (Bonferroni corrected  $\alpha=.025$ ) revealed that both groups performed at similar speeds for children's faces, ( $t(64)=-.19$ ,  $p=.85$ ,  $d=-.05$ ), but controls were faster than trainee teachers at responding to own age faces ( $t(64)=2.71$ ,  $p<.01$ ,  $d=.67$ ). I have no explanation for why the controls were faster than the trainee teachers with own-age faces. However, in terms of the difference in speed of responding to own- and other-age faces, the results for the control group are consistent with an own-age bias, while those for the trainee teachers are not.

### 3.3.3. *Correlations between Contact and Own-Age Bias Indices*

As part of the procedure to ensure operationalisation of contact had been successfully carried out, participants were asked to indicate how many months experience they had working with children. The relationship between this level of contact and the magnitude of own-age bias was investigated for the trainee teachers. To create an index of the size of the participant's own-age bias in terms of accuracy, each participant's  $d'$  score for children's faces was subtracted from their score for own age faces. Thus the larger the score, the more pronounced the own-age bias. The same was done for the RT data, creating difference RT scores. A negative score represented a faster response to own age faces, while a positive score indicated the opposite. Spearman correlations revealed no significant relationship between contact and own-age bias for either accuracy ( $r_s=.24$ ,  $p>.05$ ) or RT data ( $r_s=-.15$ ,  $p>.05$ ).

### 3.4. Discussion

Previous research has suggested that we are better at recognising faces of our own age group than those of a different age (e.g. Wright & Stroud, 2002), however the reasons for this remain unclear. Inspired by explanations of the own-race bias, the present study investigated the role of contact in the own-age bias in face recognition. It was found that the controls exhibited a significant own-age bias in terms of response speed (and of nominal significance in terms of accuracy). In contrast, trainee teachers (who had high exposure to primary school children) showed no own-age bias; in fact they were faster at recognising children's faces than own-age faces, although this pattern was not borne out in terms of accuracy.

Correlations yielded no significant relationships, however this may have been due to the fact that participants did not have enough variability in their experience with children, as they were all only at the start of their careers. For example, deHeering and Rossion (2008) found a significant relationship between the magnitude of the differential face composite effect for adult versus child faces and experience with children when participant's experience was measured in years (range of experience: 1-17 years of teaching). So it may be that a greater range and magnitude of experience is needed to see evidence of a correlational relationship between contact and the own-age bias. However, the lack of significant correlations within this study may also be due to fairly crude self-report estimates of contact (months working with children) which may be distorted by inaccuracies of memory and response bias. As such, the accuracy of the exposure information provided may be open to question and thus it may be more

beneficial to consider the results of the analysis operationalising contact into “high” and “low” groups.

In terms of reaction times, the results of this study appear to support a contact-type explanation of the own-age bias. A review of the current literature on the own-age bias also suggests that this might be a valid account. By looking at where each of the own-age bias papers recruited their participants from, they could be classed as either “high own-age exposure” settings, or not (see Table 3.2.).

For example, undergraduates recruited from universities, school children recruited from schools and older adults recruited from retirement communities are likely to have high levels of daily exposure to own-age faces. In contrast, groups recruited from the local community or through advertisements placed in the media are likely to have more varied own-age exposure levels. What is apparent from the summary of these papers in Table 3.2. is that of the 18 cases where there was an observed own-age bias, 89% of them involved groups recruited from “high own-age exposure” settings.

Clearly contact has a role to play in the own-age bias, but how exactly does it exert its effects? In light of the results of this study, let us reconsider the possible explanations for biases in face processing that were outlined in the introduction. The “improved perceptual processing” explanations (e.g. Valentine 1991, Rhodes et al 1989) suggest that, in terms of the own-race bias, the increased exposure to faces of our own racial group allows us to acquire more expertise in the perceptual processing of those faces. This, in turn, leads to better representation (e.g. Valentine, 1991) and/or enhanced configural/holistic processing of these faces (e.g. Rhodes et al.1989; Tanaka, Kiefer & Bukach, 2004; Michel, Rossion, Han, Chung & Caldara, 2006).

**Table 3.2 Summary of the role of own-age contact in studies investigating the own-age bias in face recognition**

	<b>Age of Participants</b>	<b>Age-Matched Stimuli?</b>	<b>High Own-Age Contact Setting?</b>	<b>Is there an OAB</b>
<b>Barlett &amp; Leslie, 1986 (Exp 1)</b>	Young Adults	✓	✓	✓
	Older Adults	✗	✗	✗
<b>Barlett &amp; Leslie, 1986 (Exp 2)</b>	Young Adults	✓	✓	✓
	Older Adults	✗	✗	✗
<b>Mason, 1986</b>	Young Adults	✓	✓	✓
	Older Adults	✗	✗	✗
<b>Backman, 1991</b>	Young Adults	✓	✓	✓
	Older Adults	✗	✗	✓
	76 year olds	✗	✗	✗
	85 year olds	✗	✗	✗
<b>Fulton &amp; Bartlett, 1991</b>	Young Adults	✓	✓	✓
	Elderly	✗	✗	✗
<b>Chung, 1997</b>	Children	✗	✓	✓
	Young Adults	-	✓	✗
<b>Wright &amp; Stroud, 2002</b>	Young Adults	✓	✓	-
	Middle-aged Adults	✗	✗	-
<b>Memon et al, 2003</b>	Young Adults	-	✓	✗
	Older Adults	-	✗	✗
<b>Perfect &amp; Harris, 2003</b>	Young Adults	✓	✓	-
	Older Adults	✓	✗	-
<b>Anastasi &amp; Rhodes, 2005</b>	Children	✓	✓	✓
	Older Adults	✗	✓	✓
<b>Perfect &amp; Moon, 2005</b>	Young Adults	✓	✗	✓
	Older Adults	✓	✗	✓
<b>Anastasi &amp; Rhodes, 2006 (Exp 1)</b>	Young Adults	✓	✓	✓
	Middle-aged Adults	✓	✓	✓
	Older Adults	✓	✓	✓
<b>Anastasi &amp; Rhodes, 2006 (Exp 2)</b>	Young Adults	✓	✓	✗
	Older Adults	✗	✓	✓
<b>Kuefner et al, 2008 (Exp 2)</b>	Young Adults	✓	✓	✓
<b>Weise et al, 2008</b>	Young Adults	✓	✓	✓
	Older Adults	✗	✗	✗
<b>Crookes &amp; McKone, 2009</b>	Children	✓	✓	✓
	Young Adults	✓	✓	✗

- indicates information was not specified

This is a viable explanation of the own-race bias. It could also explain demonstrations of the own-age bias by younger people trying to recognise older faces with which they have not yet had much experience (e.g. Wright and Stroud 2002). However at first sight, "improved perceptual processing" accounts struggle to explain

the own-age bias shown by the controls in the present study and the existence of own-age biases for all age-groups (e.g. Perfect & Harris 2003; Anastasi & Rhodes 2005, 2006). This is because adults have presumably had ample opportunity to develop the most efficient mechanisms for processing faces younger than themselves when they themselves were young.

The "improved perceptual processing" class of explanation could explain own-age biases by older people for younger faces if one allows for the possibility that face representations are continually updated on a day-to-day, moment-to-moment basis; where expertise is not maintained in the absence of exposure. Facial adaptation studies (reviews in Clifford and Rhodes, 2005) show that recent exposure can markedly affect our subsequent perception of faces. This might explain why adults find it harder to recognise children's faces: current experience with adult faces, and correspondingly less experience with children's faces, could lead to perceptual tuning that is optimised for the former. Such an explanation could also account for the trainee teachers' enhanced performance with children's faces, because they have had more recent experience with them.

However, there is also evidence against "perceptual expertise" explanations: Perfect and Moon (2005) investigated whether the own-age bias was affected by inverting faces. Previous research has shown that inversion affects own-race faces to a larger extent than other-race faces, resulting in the reduction (or even removal) of the own-race bias that is seen in upright faces (Rhodes, et al.1989; Sangrigoli & de Schonen, 2004). Similarly, if the own-age bias is the result of more efficient configural processing as the result of increased contact, then one would expect to see a comparable pattern observed for own- and other age faces. This, however, was not the case. Instead

of inversion reducing the own-age bias, Perfect & Moon found that inverting the faces in fact magnified it. These results suggest that a configural-expertise account of the own-age bias may not be appropriate.

However, before one accepts this interpretation, it should be noted that a recent study has found a very different pattern of results. In direct support of a perceptual expertise account, Kuefner et al (2008) demonstrated that while undergraduates exhibited a classic own-age bias for upright faces, this bias was completely eliminated when the faces were inverted. These findings are in line with the results of the current study.

The second type of explanation that was outlined in the introduction was in terms of "social categorisation": that in-group faces are processed more deeply, and hence more efficiently, than out-group faces (e.g. Levin, 1996, 2000; Sporer, 2001). Again, this type of theory can account for the own-race bias; but it is clear that theories based *solely* on concepts of differential processing of in-group and out-group faces are not supported by the present findings. Particularly problematic for Sporer's In-group/Out-group Model is the finding that trainee teachers performed better with children's faces (an "out-group"), than faces of their own age group (their "in-group"). The only way that the IoM could explain these results is if the children's faces, which are clearly important to the trainee teachers, were being categorised by them as "in-group". This seems unlikely, as the inclusion of people into one's in-group is usually based on self-referential information and shared characteristics that are deemed socially important (as suggested by List, 1986). Clearly, since this study has shown that exposure is important and self-referential age information is not, as currently formulated the IoM is not a plausible explanation of the own-age bias.

The third explanation outlined in the introduction emphasised the importance of motivation to attend to faces. This theory can successfully account for the current results (and explain the own-race bias, see Wright, Boyd & Tredoux 2003), correctly predicting that teachers and controls would be similar in accuracy with adult faces, but *not* with children's faces. Compared to the controls, the trainee teachers have higher exposure to children's faces on a day-to-day basis. However it is also likely that they have higher motivation to distinguish between these faces due to their occupational demands and thus are likely to attend to them to a greater extent. More generally, motivation is likely to be a factor in the normally observed own-age bias, perhaps due to the social rewards and punishments associated with being able to effectively (or not) distinguish between and recognise people belonging to one's own age group. Thus the data could support an explanation of the own-age bias in terms of motivation and interest for the faces.

In summary, the present findings suggest that contact plays an important role in mediating the own-age bias in face recognition. At present, it is difficult to choose between a perceptual expertise explanation (at least, one that assumes expertise is not maintained in the absence of exposure) and a motivational account. One way to do this would be to manipulate motivation and current exposure independently; research which will be discussed in the next chapter. Further research could also investigate how manipulations of configural/holistic information affect the processing of faces of different ages, as in both the Kuefner et al (2008) and deHeering and Rossion (2008) studies discussed above. This would provide further insight into the possible role of perceptual expertise in the own-age bias, and research to this effect is discussed in Chapter 6.



## Chapter 4

### 4.1. Introduction

The preceding chapter demonstrated the important role that contact plays in the own-age bias in face recognition. In line with previous research, Experiment 2 found that high occupational exposure to other-age faces resulted in the elimination of the own-age bias (e.g. Kuefner et al, 2008). However, while this illustrates that an experience-based account of the own-age bias may provide an appropriate explanation of this phenomenon, it does not shed any light on the specific aspects of this experience that might be important. For example, it is likely that the two groups have similar experience with own age faces. However, while teachers have higher exposure to children's faces on a day-to-day basis compared to the controls, it is also likely that they have higher motivation to distinguish between those faces due to their occupational demands. Thus teachers are likely to attend to children's faces to a greater extent than controls, giving them a higher *quality* of exposure as well as *quantity*.

To try and understand what aspects of contact may be responsible for the own-age bias, it is worth consulting the plethora of existing research on the own-race bias investigating the same issue. The role of contact in the own-race bias is something that has received a lot of attention in the face recognition literature, producing mixed results. The main prediction of the contact hypothesis is that individuals with more interracial experience will show a reduced cross-race effect (i.e. the relative difference between own-race and other-race face recognition will be diminished) compared to those with

less interracial experience. This theory has been investigated throughout the own-race bias literature using three main paradigms which will be reviewed below.

#### *4.1.1. Self-Report Measures of Contact*

Contact level has most frequently been ascertained through some form of self-report measure, generally asking about various aspects of contact, in an attempt to get a good representation of a participant's experiences with other race members. However, studies investigating the relationship between self-report measures of inter-racial contact and the magnitude of participants' own-race bias have yielded inconsistent results. For example, while some studies have found a significant relationship between these two variables (e.g. Byatt & Rhodes, 1998; Carroo, 1986, 1987; Lavrakas, Buri & Mayzner, 1976; Lindsay et al., 1991; Slone et al., 2000; Wright et al., 2003), others have not (Brigham & Barkowitz, 1978; Cross et al., 1971; Malpass & Kravitz, 1969; Walker & Hewstone, 2006).

One possible explanation for the inconsistencies found in the own-race bias literature may be due to the measures of contact that have been used. For example, self report measures are notoriously prone to biases in self-presentation and demand characteristics, particularly when investigating sensitive issues such as other inter-racial experience and attitudes (Valentine, Chiroro, & Dixon, 1995). In addition, such measures may be distorted by inaccuracies of memory, resulting in potentially large amounts of error in exposure information. Thus, future research may benefit from the use of more observable indexes of contact (Slone et al, 2000) that can be independently measured and/or corroborated.

Another potential reason why conflicting results have been found could be due to the way that different researchers define and try to measure “contact”. These studies tend to use cumulative, quantitative measures of contact and assume that the relationship between this and the own race bias is a linear one. This is an unfounded assumption. It is perfectly plausible that there may be a contact level at which performance for other-race faces becomes equal to that of own-race faces, and contact above and beyond this level results in little recognition improvement. It may also be that using cumulative inter-racial experience scores as an index of contact may not be tapping into the important dimensions of experience necessary to eliminate the own-race bias in face recognition.

As Slone et al (2000) pointed out, contact can be conceptualised and measured according to two distinct dimensions: quantity and quality of contact. In addition, the measure of quantitative exposure can also be broken down into two, more specific components. Firstly, amount of contact could refer to the amount of time spent with the faces of a particular group (i.e. the *frequency* of exposure). Secondly, it could denote the quantity of facial exposure in terms of the number of faces one has encountered (i.e. the *variability* of faces seen). Considering the complexity of “contact” as a variable, it is hardly surprising that studies investigating self-reported exposure have yielded inconsistent results.

One of the main problems with trying to measure a multifaceted variable such as contact is that, just as it has no single unified definition, it also has no single measure which researchers have used to quantify/qualify it. As such, self-report measures of contact have varied considerably, with some asking only one or two questions about inter-group experience (e.g. Byatt & Rhodes, 1998) and others using in-depth

questionnaires comprising items referring to a number of qualitative and quantitative aspects of this variable (e.g. Brigham et al, 1993; Slone et al, 2000). But even in the latter case, it is easy to see why significant relationships have not always been found between contact and the magnitude of the in-group bias. For example, the most commonly used of these measures, developed by Slone et al (2000), did not attempt to separate out the component parts of frequency, variability and quality of exposure. Instead they used a composite score containing all three (albeit separated across different social settings). As such, independent variations along these three components make it unlikely that the resultant score will represent a meaningful, linear measure of contact. Thus, studies using self-report measures of contact are unlikely to yield reliable conclusions about the impact of contact on own-group biases.<sup>9</sup> The types of problems encountered by studies using self-report measures are various and plenty. When considering the role of contact in the own-age bias, it may therefore be more prudent to place more weight on studies using less problematic study designs.

#### 4.1.2 *Operationalising Contact*

A second, more successful technique that has been used to investigate the influence of contact in terms of the own-bias literature is a method that operationalises contact into “high” and “low” exposure groups, based on prior knowledge of

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<sup>9</sup> Interestingly though, these studies have provided support for the idea that *recent* exposure is most important in the mediation of own-group biases (at least in terms of the own-race bias: Byatt & Rhodes, 1998; Slone et al, 2000).

participants' social, occupational or geographical surroundings (as in Experiment 2; Chiroro & Valentine, 1995; Cross et al., 1971; Feinman & Entwisle, 1976; Kuefner et al., 2008; Li, Dunning, and Malpass, 1998; Wright, Boyd, & Tredoux, 2003). The most common outcome of these types of studies is that contact does indeed appear to play a role in these own-group biases (but see Ng & Lindsay, 1994 for conflicting results). However these types of studies make it difficult to establish what aspect(s) of contact is/are at play in the mediation of these effects. For example, those who attend a multi-racial college or who have high inter-age group exposure are likely to differ from those who do not in terms of frequency, variability and quality of inter-group experience.

However, at least two studies in the own-race bias literature have used this type of paradigm to tease apart the effects of quality and quantity of inter-racial contact with some success. Chiroro and Valentine (1995) and Wright, Boyd and Tredoux (2003) identified participants who had similarly high contact to other-race faces in terms of frequency and variability (in that they attended the same multi-racial college), but who were likely to have differed in terms of the quality of interactions that they had with other-race faces as a result of wider political and social factors. Both authors found an asymmetrical own-race bias in these groups which they hypothesized was the result of the qualitatively different motivations of the two groups to attend to other-race faces (see section 1.8.1.1. for a more in depth discussion of these findings). Thus quality of contact may be an important factor in the own-race bias.

#### *4.1.3. Training Methods*

A third method that has been employed to investigate the role of contact in the own-group bias literature is that of using facial training paradigms. In terms of the

own-race bias, these studies have yielded relatively successful results, producing evidence of a significantly reduced own-race bias following training with other-race faces (e.g. Elliott, Wills & Goldstein, 1973; Goldstein & Chance, 1985; Hills & Lewis, 2006; Lavrakas, Buri & Mayzner, 1976; Malpass, Laviguer, & Weldon, 1973; but see Brigham, Bennett and Butz, 2005 for conflicting findings). These studies have highlighted the important role of recent quantitative inter-racial exposure in the reduction of the own-race bias. However some have also shown the role of more qualitative elements to be important, demonstrating training to be significantly more effective when motivational and/or attentional manipulations accompany exposure. For example, Malpass, Laviguer, & Weldon (1973) gave participants a visual training task where they had practice at (and either electric shock, verbal or no feedback for) an own- and other-race discrimination task comprising more than 200 faces. After only one hour's training, participants' own-race biases were significantly reduced, albeit temporarily, and this reduction was particularly evident in the electric shock feedback condition. As such, it is highly likely that participants in this condition were more motivated to attend to the faces and make correct responses than those in either the verbal or no feedback condition.

In a more recent study, Hills & Lewis (2006) demonstrated that the type of attention paid to faces is an important factor in the own-race bias. As part of their training, Caucasian participants were asked to shift their attention to either diagnostically African-American features, non-critical facial features or to non-facial features. While exposure time to other-race faces was the same in all three conditions, the other-race effect was only ameliorated for participants who were in the first

condition. This suggests that quality of exposure may have a more important role to play in the own-race bias than quantity.

#### *4.1.4 Contact and the Own-Age Bias*

To date, two studies (other than that described in Chapter 3) have investigated the role that other-age contact may play in the own-age bias. First, Kuefner et al (2008) operationalised participants into two groups: high and low contact with other age faces (i.e. undergraduate students or primary school teachers). Using an inversion paradigm, the authors asked the two groups to recognise adult and children's faces. When the faces were upright, the low contact group performed most accurately with own-age faces, while the high contact group were similarly accurate for both stimuli groups. The authors also found that inverting the faces produced a greater inversion effect for adult faces compared to child faces in the low contact group, while the inversion cost was similar for both facial age groups for the high contact participants. These results appear to support a contact hypothesis for the own-age bias, specifically indicating that a perceptual expertise explanation may be appropriate.

A second study by deHeering and Rossion (2008) also operationalised participants into high and low contact groups using primary school teachers and similarly aged controls. In this case, the authors did not investigate the own-age bias in terms of recognition accuracy, but using a face matching task with a composite face paradigm (see Section 1.2.1). Participants viewed pairs of child and adult composite faces (comprising different individuals in the top and bottom halves of the faces that were either presented in alignment or not) and were asked to indicate whether the individuals in the top halves of the faces were the same or different.

In line with a perceptual expertise account of the own-age bias, the low contact group's performance was significantly more impaired by face-half alignment when the composite faces comprised adult faces compared to when they comprised child faces. In contrast, the high contact group showed no significant difference in their performance for the two composite face types. In addition, using a self-report measure of contact deHeering and Rossion (2008) found that the amount of experience the high contact group had with children was significantly correlated with the size of the difference in their composite face effect for own- and other- age faces, providing further supporting evidence for the role of expertise in the own-age bias.

Both of the above studies provide support for a perceptual expertise, contact-type account of the own-age bias. In addition, the finding that amount of experience was significantly correlated with differential composite face effect magnitude (deHeering and Rossion, 2008) also sheds some light on the aspect of contact that might be important in the own-age bias. Specifically, a correlation of this nature appears to suggest a quantitative, rather than qualitative, relationship between the two variables.

However, as the high contact participants in both of the above studies were primary school teachers who differed from the low-contact participants in terms of the frequency and variability (as well as quality) of contact they had with children, it is unclear which of these two quantitative aspects of contact is likely to be most important in the mediation of the own-age bias. The purpose of this current chapter was to try and establish what aspects of contact may play an important role in the own-age bias in face recognition, using the own-race bias literature as a useful starting point. By operationalising contact type according to frequency and variability, this chapter sought



to tease apart the various components of contact involved in the own-age bias, while avoiding the use of potentially troublesome self-report measures.

#### **4.2. Experiment 3**

In Experiment 3, two aspects of quantity of exposure were examined. In order to establish this, the difference between primary and secondary school teachers' ability to recognise child (11 year olds) and own-age faces was investigated. The main reason for this was that while both groups of teachers would have relatively high contact with that age group of children, the nature of the contact differs somewhat. In the UK, primary school teachers teach one class for the whole year, (i.e. they have a core group of around 30 pupils who they see almost daily). In contrast, secondary school teachers are responsible for teaching their subject, and therefore teach a range of classes and year groups. As such, primary school teachers tend to have more face-to-face contact with their students in terms of *frequency*, but they see less of a *variety* of that age group than secondary school teachers (largely due to the fact that secondary schools are bigger and have several classes making up one year group). Thus if contact frequency is the crucial aspect of other-age experience needed to eliminate the own-age bias, then the primary school teachers should show a smaller own-age bias than the secondary school teachers. If however, variability of contact is more important, then the opposite pattern should be observed.

#### 4.2.1. *Design*

A mixed design was used, with teacher group as the between subjects variable (with three levels: controls, primary teachers and secondary teachers) and age of facial photograph as the repeated measures variable (child – 11-12 years old and adult – 20-30 years old). Measures of accuracy and reaction time (RTs) were taken for the dependent variables.

#### 4.2.2. *Participants*

There were 88 participants in total; however two of the primary school teachers' data had to be excluded as they had never taught Year 6 before. A further two controls had to be excluded, as they had recent experience working with primary school aged children. Included in the analysis were 27 primary school teachers (22 females, total mean age = 28.78, SD = 3.08, range = 22-33 years), 29 secondary school teachers (18 females, total mean age = 28.93, SD = 2.33, range = 23-32 years) and 28 controls (18 females, total mean age = 27.00, SD = 2.92, range = 21-32 years). Participants were a combination of trainee and qualified teachers. Controls were recruited through the University of Sussex research participation volunteer pool. Teachers were recruited through a number of methods: (1) emailing people who were currently taking part in a PGCE at the University of Sussex, (2) emailing people who had successfully completed their PCGE at the University of Sussex, (3) emailing local schools asking for volunteers to take part. All of them had recent experience with teaching children in Years 6 and 7 within their schools. All participants were paid £5 for their time.

#### 4.2.3. *Materials*

Digitized photographs of 64 Caucasian faces were taken (32 males and 32 females). Half were between 11-12 years old and were obtained with parental permission. The other half of the photos were of 20-30 year olds and were taken from the CAL/PAL face database (Minear & Park, 2004). There were two photographs of each individual, one in a smiling pose and the other neutral. As with the previous experiments, all photographs were close up, frontal face images without glasses, jewellery, facial hair or other identifying features. The photographs were all converted to greyscale and edited to a standard size (300 x 350 pixels) using Adobe Photoshop software. The background of each picture and any information outside of the head outline and the contour of the chin were removed and made solid white (see Figure 2.1. for an example of the stimuli used).

#### 4.2.4. *Procedure*

The procedure was the same as in Experiment 2.

#### 4.2.5. *Results*

Since there was no effect of pose type or gender on accuracy, data were collapsed across these variables for the purpose of analysis.

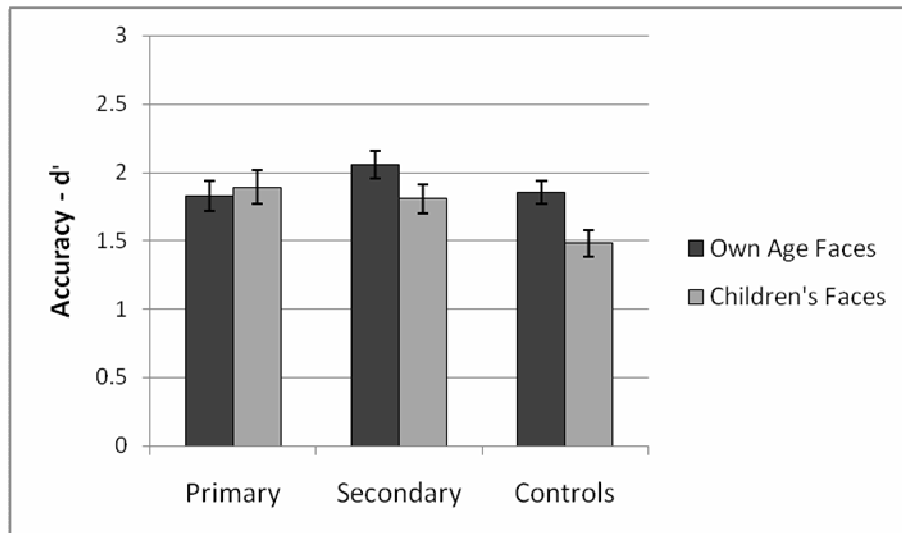
##### 4.2.5.1. *Accuracy – Discriminability*

Hit rates, false alarm rates, d-prime and c response bias scores were calculated to investigate accuracy and can be seen in Table 4.1.

**Table 4.1 Mean proportion of hits and false alarms, d' accuracy and c response criterion scores**

Teacher Group	Photograph Age	Hit Rate		False Alarm Rate		Accuracy (d')		Response Bias (c)	
Primary	Own Age	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	Children	0.79	0.12	0.18	0.07	1.83	0.57	0.03	0.31
Secondary	Own Age	0.83	0.09	0.21	0.12	1.89	0.64	-0.06	0.30
	Children	0.83	0.11	0.17	0.08	2.06	0.56	-0.04	0.30
Control	Own Age	0.79	0.11	0.19	0.11	1.81	0.58	0.05	0.32
	Children	0.81	0.08	0.20	0.08	1.81	0.43	0.02	0.21
	Own Age	0.73	0.10	0.22	0.09	1.46	0.52	-0.07	0.17
	Children								

Figure 4.1. shows the mean d' score for both experimental groups for the stimulus conditions. Both groups appear to have been able to identify whether or not a face was familiar across all conditions at above chance levels ( $d' > 0$ ).



**Figure 4.1 The effect of face age on mean d-prime accuracy scores for the different groups (error bars show mean  $\pm 1$  standard error)**

A two-way mixed ANOVA (three levels of group x two levels of face age) revealed that there was no significant main effect of group on d' accuracy scores ( $F(2, 81)=3.03, p>.05, \eta_p^2=.07$ ). However, there was a significant main effect of face age ( $F(1,81)=7.32, p<.01, \eta_p^2=.08$ ) such that own-age faces were remembered significantly

better (mean = 1.91, .53) than children's faces (mean = 1.72, .60). In addition, there was a significant interaction between these two variables ( $F(2,81)=3.40$ ,  $p<.05$ ,  $\eta_p^2=.08$ ).

Follow up univariate ANOVAs revealed that while all three groups performed similarly for own age faces ( $F(2, 81)=1.80$ ,  $p>.05$ ,  $\eta_p^2=.04$ ), there was a significant effect of group for their performance with child faces ( $F(2, 81)=4.24$ ,  $p<.05$ ,  $\eta_p^2=.10$ ). Bonferroni post-hoc tests revealed that this was the result of the primary school teachers performing significantly more accurately than the control group ( $t(53)=2.73$ ,  $p<.05$ ).

Individual Bonferroni corrected paired t-tests<sup>10</sup> (new  $\alpha = .017$ ) for each experimental group revealed that the effect of face age was only significant for the control group ( $t(27)=2.95$ ,  $p<.01$ ,  $d=.77$ ). While neither of the teacher groups exhibited a significant own-age bias (primary school teachers:  $t(26)=-.76$ ,  $p=.45$ ,  $d=-.10$ ; secondary school teachers:  $t(28)=1.81$ ,  $p=.08$ ,  $d=.44$ ), effect sizes suggest that this bias was eliminated to a greater extent for the primary school teachers. In fact, Figure 4.1 shows that while secondary school teachers still performed slightly better with own-age faces, the opposite was true for the primary school teachers.

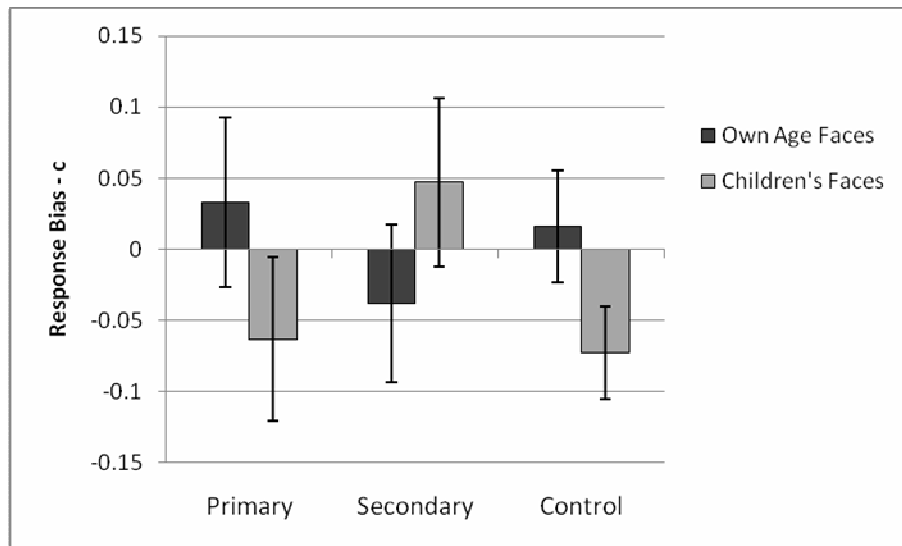
#### 4.2.5.2. Accuracy – Response Bias

Figure 4.2. shows the mean  $c$  score for both experimental groups, for the two face age stimulus conditions. As with the previous studies the  $c$  values were very close to 0 (no scores exceeding  $\pm .07$ ), suggesting that there is very little response bias in this

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<sup>10</sup> All follow-up tests in this study are 2-tailed.

study. In fact, one-sample t-tests revealed that the magnitude of response bias only differed from 0 in one condition; when controls were recognizing children's faces ( $t(27)=-2.25, p<.05$ ).



**Figure 4.2** The effect of face age on c response bias scores for the different experimental groups (error bars show mean  $\pm 1$  standard error)

A 2x3 mixed ANOVA revealed no significant main effects or interactions (largest  $F=1.57$ ).

#### 4.2.5.3. Latency

To minimize the variability often found in reaction time (RT) data, the same procedure was used as in Experiments 1 and 2. 2.2% of the primary school teachers' responses, 2.2% of the secondary school teachers' and 2.3% of the controls' responses were replaced in this way. Corrected mean RTs are shown in Figure 4.3.

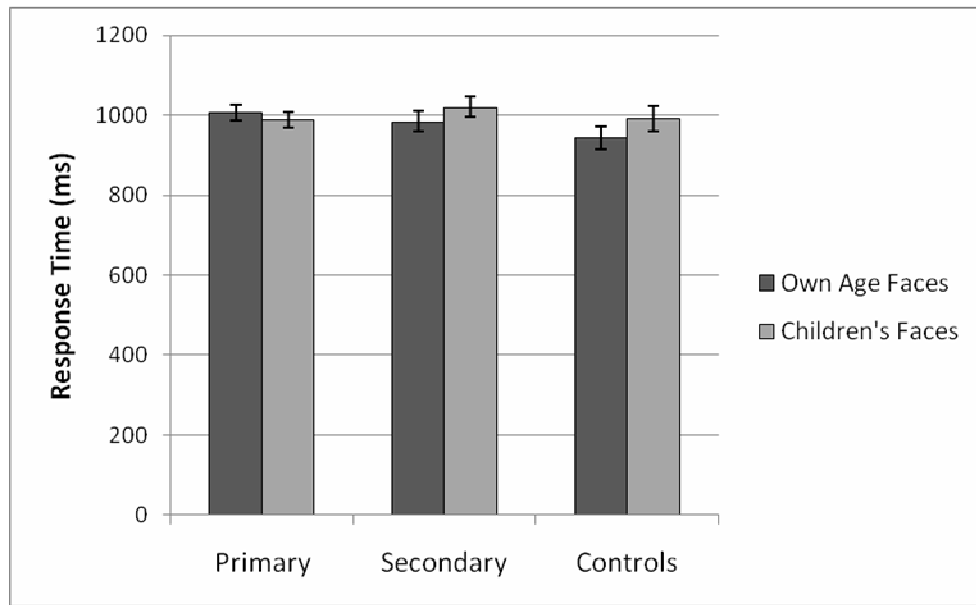


Figure 4.3 Mean reaction times for correct responses for the different face age stimuli for the three groups (bars show mean  $\pm$  1 standard error).

Mean RTs for correct responses were entered into a mixed 2 x 3 ANOVA with face age and group as variables of interest. While there was no significant main effect of group ( $F < 1$ ), the effect of face age reached significance ( $F(1,81)=6.10, p < .05, \eta_p^2 = .07$ ): participants responded to own-age faces faster than children's faces (mean = 977.68, 132.76; mean = 1000.93, 137.06 respectively). In addition, there was a significant interaction between these two variables ( $F(2,81)=5.21, p < .01, \eta_p^2 = .11$ ).

Follow up univariate ANOVAs revealed that all three groups performed similarly for both own age ( $F(2, 81)=1.66, p > .05, \eta_p^2 = .04$ ) and children's faces ( $F < 1$ ). Individual Bonferroni corrected paired t-tests (new  $\alpha = .017$ ) for each experimental group revealed that the effect of face age was only significant for the control group ( $t(27)=-4.76, p < .001, d = -.31$ ). While neither of the teacher groups exhibited a significant own-age bias (primary school teachers:  $t(26)=1.21, p = .24, d = .19$ ; secondary school teachers:  $t(28)=-1.85, p = .08, d = -.27$ ), effect sizes suggest that this bias was

eliminated to a greater extent for the primary school teachers. As with the accuracy data, Figure 4.3 shows that while secondary school teachers still performed slightly better with own-age faces, the opposite was true for the primary school teachers.

#### 4.2.6. *Discussion*

Results from Experiment 3 show that while controls exhibited a significant own age bias, both in terms of accuracy and response speed, neither of the teaching groups showed any such effect. However the effect sizes indicate that the magnitude of the own-age bias (or lack thereof) was smaller for primary school teachers in both cases. In addition, only the primary school teachers performed significantly better than controls for children's faces, although this pattern was only seen in terms of accuracy. This is consistent with the notion that frequency of exposure to other-age faces may play a more crucial role in the elimination of the own-age bias than the variability of faces seen.

However, while this study sought to separate two types of quantitative contact, it may be that the results reflect a more qualitative measure. As primary school teachers tend to have more face-to-face contact with a smaller amount of students than secondary school teachers, it may be that the quality of the contact that they have with children is more personal and of a higher quality than the student-teacher interactions experienced in secondary schools. In order to tease apart these factors, future research in this area could attempt to specifically operationalise contact according to qualitative exposure to other-age faces, while keeping the more quantitative dimensions constant. For example, as with the previously mentioned own-race bias studies (e.g. Chiroro & Valentine, 1995; Wright, Boyd, & Tredoux, 2003), this type of study could take two groups of



participants who both have high levels of contact with other-age faces, but who vary in terms of the quality of the interactions they have with these faces (e.g. teachers and school janitors).

However, one problem with this type of study, and one of the shortcomings of Experiment 3, is that while it can control for the quantity of contact participants have with faces (to a degree), it does not account for the myriad of other variations that might naturally occur between two different occupational groups. As such, in order to try and separate out the effects of quantity and quality of inter-age group exposure on face recognition, Experiment Four used a more controlled, lab-based “training” study to manipulate participant’s exposure to other-age faces and their motivation to differentiate them.

### **4.3. Experiment 4**

#### *4.3.1. Design*

A mixed design was used, with training group as the between subjects variable (with four levels: no training, exposure, motivation and motivation and exposure) and face age as the repeated measures variable (with two levels: child – 8-11 years old and young adult – 18-25 years old). Measures of accuracy and reaction time (RTs) were taken for the dependent variables.

#### *4.3.2. Participants*

There were 120 participants in total, split equally into the four training groups (see Table 4.2 for their demographic information). All participants were students from

the University of Sussex, who either received research credits (in the control and exposure conditions) or were paid (in the motivation conditions) for their participation. Participants were pseudo-randomly assigned to one of the four training conditions, depending on whether they were recruited from the psychology research participation pool, or from the paid volunteer pool.

**Table 4.2. Age and gender information for the participants in the 4 training groups**

	<b>N</b>		<b>Age</b>		
	<i>Female</i>	<i>Male</i>	<i>Mean</i>	<i>SD</i>	<i>Range</i>
Motivation	21	9	21.63	3.02	18-28
Motivation & Exposure	23	7	21.63	2.50	18-27
Exposure	25	5	20.10	2.20	17-27
Control	19	11	20.40	1.83	18-25

#### 4.3.3. *Materials*

Digitised photographs of 166 Caucasian male faces were used, 83 of children (aged 7-11 years old) and 83 of young adults (aged 18-25 years old). All photographs were close up, frontal face images without glasses, jewellery, facial hair or other identifying features. Each photograph was then converted to greyscale and edited to a standard size (300 x 350 pixels) using Adobe Photoshop software. The background of each picture and any information outside of the head outline and the contour of the chin were removed and made solid white. 102 of the faces were used for the exposure phase and were obtained from a professional photographer while the remaining 64 faces were used for the recognition phase and were the same as the faces used in Experiment One. The number of faces from each age group was split equally in both phases.

#### 4.3.4. *Procedure*

Participants took part in the study individually and were all instructed that they were going to take part in a face processing experiment. The instructions were different for each condition and were presented on the computer screen.

##### 4.3.4.1. *Control Condition*

Participants were told that they would be shown a number of facial photographs and were instructed to try and remember them as best they could, in order to recognise them later. Participants were then presented with 32 of the photographs (16 from each age group) in a random order at a 3 second rate, using E-Prime. This was followed by a five-minute filler task in which participants had to remember a series of digits (the digit span task from the WAIS-III). The recognition procedure was the same as in the previous three experiments.

##### 4.3.4.2. *Motivation Condition*

In addition to receiving the instructions that were given in the control condition before the learning phase, participants in the motivation condition were told that they would receive a monetary reward for each face they correctly recognized (as performance-dependent monetary incentives have been shown to increase motivation to perform well on cognitive tasks: Epley & Gilovich, 2005; Stone & Ziebart, 1995). Participants were reminded of this again immediately before the recognition phase. In addition, following each response, they received computerized feedback with regards to how much money they had won (feedback is also believed to serve as an additional motivating factor; e.g. Bandura & Cervone, 1986; Ryan & Deci, 2000).

#### 4.3.4.3. *Exposure Condition*

Before the learning and recognition phases, participants in this condition were exposed to 102 additional faces (51 in each age group). For the exposure phase, three faces belonging to the same age group were shown on the computer screen next to each other. Which faces appeared next to which was randomised within each age group and each face appeared twice (appearing in a different triad of faces with each presentation). In total there were 68 screens, each of which appeared for 12 seconds and they were shown in 4 randomised blocks. To ensure that the participants actually processed the faces, they were asked to make personality judgements about them (e.g. Bower & Karlin, 1974; Coin & Tiberghien, 1997; Sporer, 1991). Participants were asked to decide which of the three faces they believed was the most popular amongst their peers and they responded by pressing the computer key 1, 2 or 3. Following this, the participants took part in the same procedure as for the control condition.

#### 4.3.4.4. *Motivation & Exposure Condition*

As in the exposure group, participants in this condition were shown 102 faces before the learning and recognition phases. The presentation method was identical to that described above and only differed in terms of the instructions given about the judgments they had to make about the faces. Instead of having to make personality decisions about the faces, participants were instructed to look at the sets of faces on the screen and asked to identify what information would be most useful in individuating those faces. In addition, they were informed that after the initial phase they would be given a face recognition test (using a different set of faces) in which they would be

awarded a sum of money for each of their correct responses. As such, they were encouraged to establish the best way to identify faces, as this would result in a higher monetary reward. Following this, the participants took part in the same procedure as for the motivation condition.

#### 4.3.5. Results

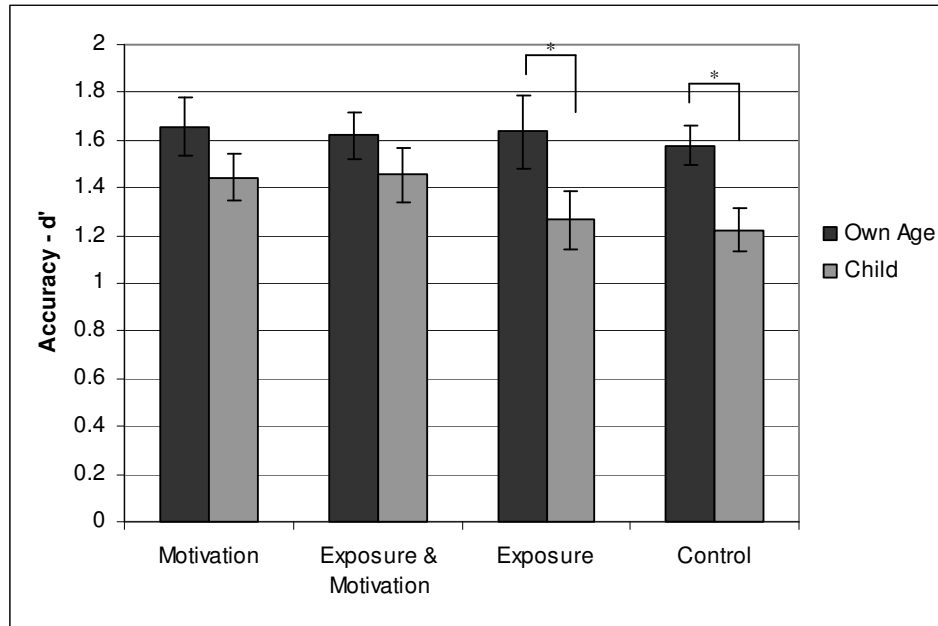
As with the previous experiments, hit rates, false alarm rates, d-prime and c response bias scores were calculated to investigate accuracy and can be seen in Table 4.3. Since there was no effect of pose type on accuracy, data were collapsed across this variable for the purpose of analysis.

**Table 4.3. Mean proportion of hits and false alarms, d' accuracy and c response criterion scores**

Training Group	Photograph Age	Hit Rate		False Alarm Rate		Accuracy (d')		Response Bias (c)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Control	Own Age	0.77	0.09	0.22	0.10	1.58	0.45	0.02	0.25
	Children	0.73	0.09	0.29	0.13	1.22	0.50	-0.03	0.24
Motivation	Own Age	0.78	0.12	0.24	0.13	1.66	0.66	-0.01	0.37
	Children	0.75	0.10	0.25	0.13	1.44	0.53	0.02	0.32
Exposure	Own Age	0.74	0.15	0.21	0.12	1.64	0.85	0.07	0.31
	Children	0.69	0.13	0.26	0.15	1.26	0.68	0.08	0.33
Motivation & Exposure	Own Age	0.75	0.14	0.22	0.14	1.62	0.54	0.07	0.43
	Children	0.73	0.12	0.23	0.12	1.45	0.64	0.09	0.30

#### 4.3.5.1. Accuracy – Discriminability

Figure 4.4. shows the mean  $d'$  score for the four experimental groups, for the two stimulus age groups. All groups performed above chance levels ( $d' > 0$ ).



**Figure 4.4** The effect of face age on mean  $d'$ -prime accuracy scores for the different training groups (error bars show mean  $\pm 1$  standard error). Asterisks represent significance for the differences in accuracy between the two face ages (Bonferroni corrected alpha:  $p < .0125$ ).

A two-way mixed ANOVA (four levels of group x two levels of face age) revealed that there was an overall significant main effect of face age ( $F(1,116)=22.33$ ,  $p < .001$ ,  $\eta_p^2 = .16$ ) on  $d'$  accuracy scores, with performance being better for own age faces. However, there was no significant main effect of group and no interaction between the two variables ( $F < 1$  in both cases).

As specific a priori hypotheses were made about the fact that training might differentially affect the magnitude of participants' own-age bias, despite the fact that no significant interaction was found between group and face age, individual contrasts were

performed to investigate the extent of the own age bias for each age group<sup>11</sup>. These revealed an interesting pattern (and are illustrated in Figure 4.4.). Paired t-tests with Bonferroni corrected alphas (new  $\alpha = .0125$ ) demonstrated that while participants were significantly better at recognising own age faces in the “control” and “exposure” conditions ( $t(29) = 3.13, p < .01, d = .76$ ;  $t(29) = 2.87, p < .01, d = .48$  respectively), no such own-age bias was present in either the “motivation” or “motivation and exposure” condition ( $t(29) = 1.89, p = .07, d = .37$ ;  $t(29) = 1.51, p = .14, d = .29$  respectively). Therefore, while it seems likely that motivation to attend to faces is more important in mediating the own age bias than simple exposure to other age faces, it was the combination of both factors that produced the lowest effect size.

#### 4.3.5.2. *Accuracy – Response Bias*

Figure 4.5. shows the mean  $c$  score for both experimental groups for the two face age stimulus conditions. As with the previous studies the  $c$  values were very close to 0, suggesting that there was very little response bias in this study. In fact, one-sample t-tests revealed that the magnitude of response bias did not differ from 0 in any of the conditions ( $t$  range =  $-.58 - 1.59$ ).

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<sup>11</sup> See Crookes and McKone (2009) for a similar justification regarding a priori hypotheses.

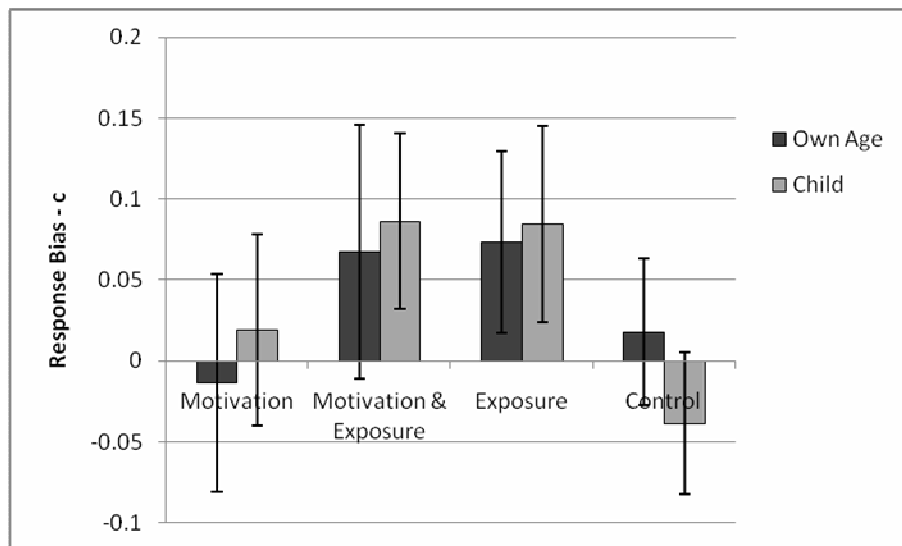


Figure 4.5 The effect of face age on c response bias scores for the different groups (error bars show mean  $\pm 1$  standard error)

A 2 x 4 mixed ANOVA revealed no significant main effects or interactions ( $F < 1$  in all cases).

#### 4.3.5.3. Latency

Again, variability in reaction time (RT) data was reduced using the same method as in the previous studies. 2.6% of the control group's responses, 2.4% of the motivation group's, 2.5% of the exposure group's and 2.5% of the motivation and exposure group's reaction times were replaced in this way. Corrected mean RTs are shown in Figure 4.6.



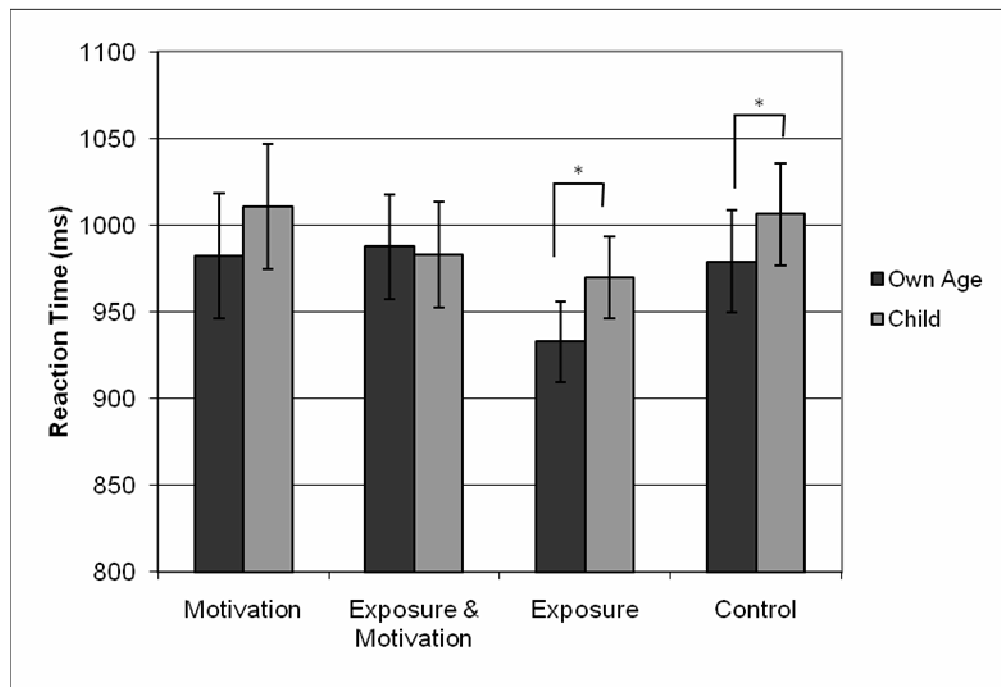


Figure 4.6 Mean reaction times for correct responses for the different face age stimuli for all groups (bars show mean  $\pm 1$  standard error). Asterisks represent significance for the differences in reaction times for the two face ages (Bonferroni corrected alpha: \* =  $p < .0125$ ).

The two-way ANOVA for reaction time data revealed that there was an overall significant main effect of face age ( $F(1,116)=11.74, p < .001, \eta_p^2 = .09$ ) with participants responding faster to own age faces. However, there was no significant main effect of group ( $F(1,116)=2.01, p = .12, \eta_p^2 = .05$ ) and no interaction between the two variables ( $F < 1$ ).

While no significant interaction was found between group and face age, individual contrasts investigating the extent of the own age bias for each age group revealed an interesting pattern (as illustrated in Figure 4.6.). Paired t-tests with Bonferroni corrections (new alpha = 0.0125) demonstrated that while participants were significantly faster at correctly recognising own age faces in the “control” and “exposure” conditions ( $t(29) = -2.62, p = .01, d = -.17$ ;  $t(29) = -2.88, p < .01, d = -.24$  respectively), there was no such own-age bias present in either the “motivation” or

“motivation and exposure” condition ( $t(29) = -2.26, p=.03, d = -.14$ ;  $t(29) = .30, p=.77, d = .03$  respectively).

#### 4.3.6. *Discussion*

Results from Experiment 4 demonstrated that while exposure to other-age faces did not significantly reduce the own-age bias, motivation to attend to the faces did appear to mediate this bias. However, it seems that a combination of both exposure to faces and motivation to attend to those faces yielded the most successful elimination of the own-age bias, causing participants to respond similarly to own- and other- age faces both in terms of accuracy and response speed. It is of note, however, that due to the fact that there was no significant effect of or interaction with group, interpretation of the individual t-tests should be taken with caution (even with the conservative Bonferroni corrections).

### 4.4. **General Discussion**

Previous research has illustrated the importance of contact with out-group (i.e. other age, or other race) faces in reducing own-group processing biases. For example, contact has been shown to reduce both the own-age bias (e.g. Kuefner et al, 2008; Harrison & Hole, 2009) and the extensively researched own-race bias (e.g. Byatt & Rhodes, 1998; Chiroro & Valentine, 1995; Li, Dunning, and Malpass, 1998; Malpass, Laviguer, & Weldon, 1973; Wright, Boyd, & Tredoux, 2003). However, while contact appears to mediate the magnitude of these own-group biases, little research has investigated exactly what it is about contact that exerts these effects. While researchers

acknowledge the fact that contact has both qualitative and quantitative elements, few have attempted to separate these two aspects.

Experiment 3 sought to investigate the role of two quantitative aspects of contact in mediating the own-age bias: frequency and variability of other-age faces seen. The results showed that the own-age bias was eliminated in both of the groups with high inter-age group contact, despite them having different exposure types to other-age faces. While secondary school teachers have more experience with a wider variety of faces, they have less time spent with these children than the primary school teachers.

While neither teaching group showed an own-age bias, effect sizes suggested that this bias was eliminated to a greater extent amongst the primary school teachers. The finding that only this teaching group performed significantly more accurately than controls for the children's faces also supports this claim. These results suggest that time spent with other age faces may play a more important role in moderating the own-age bias than the amount of faces one has experience with. However, it is possible that these findings may reflect a difference in the quality of experience that the two sets of teachers have with other-age faces, rather than the quantity (or some other systematic difference between these two occupational groups, see Section 4.2.6.). As primary teachers teach one class throughout the school year, it is likely that the quality of the interactions they have with their students is different from those experienced by the secondary teachers who see a wide range of classes for only a couple of hours a week.

In the own-race bias literature, there are a couple of studies that have provided evidence for the important role of contact *type*, as opposed to *level*, in moderating the own-race bias (Chiroro & Valentine, 1995; Hills & Lewis, 2006). Specifically, these studies suggest that motivational and attentional factors may be crucial in mediating

such own-group effects. In order to try and disambiguate the findings of Experiment 3 and to try and establish whether quality or quantity (or both) is important in the mediation of the own-age bias, Experiment 4 used a training paradigm to try and shed some light on this issue. By giving participants either prior exposure to other-age faces, or increasing their motivation to attend to these face, this study found that exposure alone was not enough to eliminate the own-age bias. In contrast, increasing participants' motivation to attend to the faces did appear to mediate this bias (both in terms of accuracy and reaction time). However, it seems what was most effective in the elimination of the own-age bias (judging by the reported effect sizes) was a combination of both exposure to other-age faces and motivation to attend to those faces.

Before one accepts this interpretation of the results, it is important to consider the limitations of this study. Firstly, it should be noted that only participants in the "motivation" and "motivation and exposure" conditions received feedback for their responses, and as such these two experimental conditions were systematically different from the other two conditions. It may, therefore, be that this addition of feedback elicited differential response strategies in the participants rather than increasing their motivation to attend more and perform well.

In addition, when considering these results, it is important to note that there is a great difference between real-world contact with different groups of faces and that which is experienced in a laboratory training study. While this study purported to be investigating the role of motivation, exposure and a combination of these factors in the own-age bias, it is worth considering how successful these manipulations actually were at representing these factors. Firstly, how likely is it that the motivations associated with remembering faces in a social setting will be similar to those one has for receiving

a relatively small monetary reward? As a recent study by Brase (2009) points out, motivations elicited by monetary incentives on cognitive tasks are unlikely to be generalisable to other tasks or contexts. In addition, is the viewing of triads of faces for 12 second intervals really tantamount to real-world social exposure to faces?

Another potential difficulty with interpreting the findings from this study is due to the different instructions that were given to the participants in the different experimental groups. Given that the instructions for each task were qualitatively different, it is possible that they elicited differential encoding or performance strategies. In particular, in the “motivation and exposure” condition, the instructions given specifically encouraged participants to attend to individuating facial features, which the instructions for the other conditions did not. As such it is possible that the reduction of the own-age bias in this condition was the result of participants being encouraged to actively individuate other-age faces. The consequence of specifically eliciting individuation strategies for other-age faces will be discussed further in the next chapter and the implications of this in terms of Experiment 4 will be discussed further in Chapter 7.

So while it may be relatively uncertain exactly what mechanisms are responsible for the reduction of the own-age bias in the “motivation” and “motivation and exposure” conditions, one thing is evident: qualitative aspects of exposure have an important role to play in mediating the magnitude of the own-age bias. In a similar way to Hills & Lewis’ (2006) findings with regard to the own-race bias, this study found that in the two exposure conditions, despite exposure time to other-age faces being equal, the own-age bias was only ameliorated for participants who received additional instructions designed to elicit more motivation to attend to the facial features most

appropriate for identification. Thus it seems that quality of exposure may have a more important role to play in the own-age bias than quantity (at least when quantity is over a relatively short time frame).

## Chapter 5

### 5.1. Experiment 5: Introduction

On a daily basis, we tend to come into contact with a large array of faces, either personally or through the media. However, there is evidence that we process some faces in a different manner to others. As this thesis has demonstrated, we appear to have better recognition memory for faces belonging to our own-age group. In addition, previous research has shown that we are better at recognising faces belonging to our own racial group compared to those of another race (see Meissner & Brigham, 2001 for review). Why this might be the case remains unclear. In terms of the own-age bias, Chapters 3 and 4 indicate that it is likely that recent contact with faces of a certain age group mediates our ability to recognise those faces. Similarly, contact appears to play a significant role in the own-race bias, accounting for a small, but significant proportion of the variance in this effect (Meissner & Brigham, 2001). Further exploration into what it is about the nature of contact that is important for the mediation of these biases appears to suggest that it is the *quality* of our experience with faces (e.g. our motivation to attend to some groups of faces over another) that may play a crucial role in the own-age (see Experiment 4) and own-race (e.g. Chiroro & Valentine, 1995; Li, Dunning, and Malpass, 1998; Wright, Boyd, & Tredoux, 1999) biases. However, what guides this motivation to pay attention to some faces over others remains unexplained (at least, when these faces are unfamiliar to us; the social rewards and punishments associated with familiar face recognition are obvious).

One social-cognitive explanation of why the own-age or own-race biases may occur is based on research in the social psychology literature that has demonstrated our tendency to group people into categories, according to whether they belong to our social in-group or out-group (e.g. Tajfel, Billings, Brundy & Flament, 1971). Exactly what constitutes an “in-group” or “out-group” is unclear, but the dimensions according to which these categorisations take place are likely to be based on socially salient cues that are relevant to the self (e.g. race, age, gender etc.). It is this process of social grouping that is thought to have an impact on the way in which we subsequently process a face. Out-group members tend to be thought of at a categorical level (e.g. in terms of the social categories to which they have been assigned, e.g. age, gender, race) at the expense of more individuating information, while in-group members are individuated (e.g. Bodenhausen, MaCrae & Hugenberg, 2003).

The influence of categorising stimuli according to in- and out- groups has been repeatedly seen outside the face processing literature, and has important cognitive, motivational and behavioural consequences (e.g. Tajfel et al, 1971; Tajfel & Turner, 1986). It is perhaps best characterised by the out-group homogeneity effect; the tendency to perceive members of out-groups as being more homogenous than members of in-groups (Judd and Park, 1988). More recently, the effects of these categorisations have been directly investigated in the face processing literature. For example, Bernstein, Young and Hugenberg (2007) presented participants with faces that were of the same race, gender and age-band (to eliminate categorisation or experience effects with these groupings), but which differed in terms of the labels given to them. Faces were either labelled as being from the same university as the participants, or from a rival university, to elicit in- and out- group categorisations accordingly. The authors found



that merely categorising faces according to university affiliation in this way was enough to facilitate better recognition of in-group members compared to out-group members. Bernstein et al (2007) also replicated these findings in a second study, using bogus personality types as the categories of interest.

So in/out group categorisation clearly seems to have an influence on face recognition, but the mechanisms that might underlie these effects are unclear. In terms of the own-race bias, Levin (1996; 2000) suggested that the recognition deficit for other race faces occurs as a result of people automatically emphasising visual information specifying race (e.g. skin tone) at the expense of individuating information. Specifically, people code race-specifying information in other-race faces as a salient facial feature. Levin (1996) based this theory on the finding that in addition to exhibiting a cross-race recognition deficit, almost paradoxically, participants were faster at identifying the race of other race faces (the Other-Race Classification Advantage; ORCA). Levin hypothesised that race was treated as a salient feature in other-race faces, but not in own-race faces. Once the presence of this racial feature is detected, visual processing does not progress much further, meaning individuating facial information is not encoded. As own-race faces have no other-race-specifying feature, individuating information is successfully processed.

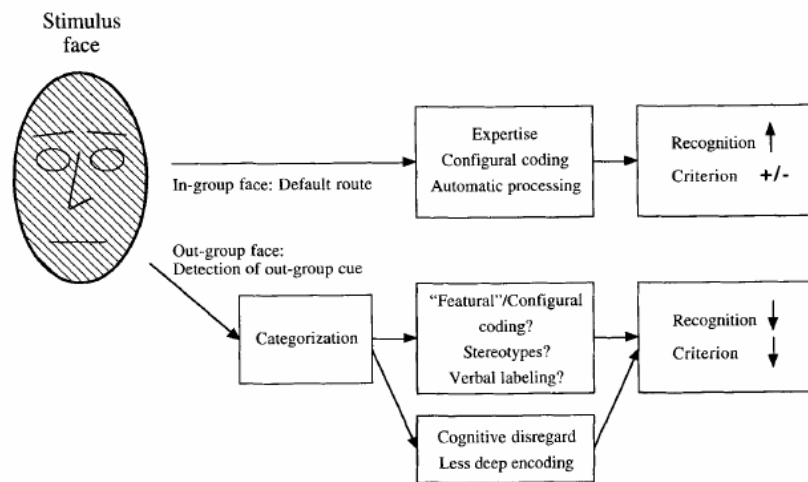
MacLin and Malpass (2001) demonstrated the importance of race-specifying cues in face recognition by using ambiguous race faces that were artificially given either a typically African-American or Hispanic hairstyle. Despite the same faces being used equally to represent either “Black” or “Hispanic” faces, the authors found that the presence of a hairstyle typical of the participant's race was enough to elicit an “own-race bias” in these faces, supporting Levin’s race feature hypothesis.

In regard to the own-age bias, a feature processing theory could also be applied. It could be that age is coded in a similar manner according to the presence or absence of age-specifying information. For example, skin surface texture cues have been identified as important in the perception of age (Burt & Perrett, 1995; George & Hole, 2000; Nkengne et al, 2008), thus the presence or absence of wrinkles could serve as such a categorising feature.

An alternative way in which categorisation may elicit poorer recognition for out-group members may be more to do with motivation and attention. For example, Rodin (1987) suggested that categorising a target as belonging to an out-group might reduce one's motivation to attend to that face, and can lead to one cognitively disregarding that face (essentially rendering the individual invisible). As out-group faces are likely to be less socially salient to us, the need and motivation to process those faces further is reduced, thus individuating information is likely to be encoded to a lesser degree than that for more socially important in-group faces. This theory gained some support in terms of the own-race bias from a recent study by Hugenberg, Miller & Claypool (2007). They found that informing participants about the own-race bias and instructing them to attend closely to the individuating characteristics of other-race faces at the encoding stage was enough to eliminate the own-race bias. This suggests that the own race bias may at least in part arise from motivational (and associated attentional) differences elicited from social categorisation.

In practice it is difficult to distinguish between a race-feature type hypothesis and a more motivational account of the social categorisation processes involved in own-group biases. In fact, more recent accounts have suggested that the two may not be separable, combining them into a more comprehensive theory of ingroup/outgroup

categorisation, as can be seen in Sporer's (2001) in-group/out-group model (IoM) of face recognition (see Figure 5.1 for a summary of this model). Thus, regardless of the specific mechanisms underlying social categorisation, recent research has suggested that this process may be at least partly responsible for producing the own-group biases seen in face recognition.



**Figure 5.1 Sporer's (2001) In-group/out-group model of face recognition.**

In terms of this thesis, if it is the case that the own-age bias is due (at least in part) to social categorisation, then the process of categorisation should be enough to elicit a recognition difference between in- and out- group faces. Thus, the labelling of faces according to an in-group category should result in better recognition of those faces compared to those labelled as out-group members. In addition, reducing the social salience of one social category (in this case, age) should be enough to reduce or even eliminate the own-age bias. In contrast, increasing the salience of an alternative social cue (in this case, gender) should facilitate an own-gender bias in face recognition.

In addition, more specific predictions can be made in terms of the underlying mechanisms that may be at play in this social categorisation. If a feature processing theory analogous to Levin's (1996; 2000) race-feature hypothesis is responsible for the own-age bias in face recognition, then one would expect to see faces belonging to one's own group (either age or gender) to be classified slower than those belonging to the out-group. In addition, this out-group classification advantage should be directly related to the degree of in-group bias; the larger the classification advantage, the bigger the deficit in correctly recognising them should be.

## **5.2. Method**

### *5.2.1. Design*

A mixed design was used. There were two between subjects variables: categorisation group (with two levels: age categorisation and gender categorisation) and gender (male and female). There were also two repeated measures variables: face age (with two levels: own-age – 20-30 and other-age - 11-12) and face gender (own-gender and other-gender). Measures of accuracy and reaction time (RTs) were taken for the dependent variables.

### *5.2.2. Participants*

There were 68 participants in total, who were randomly assigned to the two categorisation groups (see Table 5.1 for their demographic information). All were psychology students from the University of Sussex who received research credits for their participation.

**Table 5.1** Age and gender information for the participants in the two categorisation groups

<b>Group</b>	<b>Gender</b>	<b>N</b>	<b>Mean</b>	<b>Std. Dev</b>	<b>Range</b>
Gender	Female	17	20.06	2.46	18-27
	Male	17	20.82	2.63	18-26
Age	Female	17	21.47	2.76	18-27
	Male	17	20.47	2.90	18-26

### 5.2.3. *Materials*

The same materials were used as in Experiment 3. To ensure the faces belonging to both age groups and genders were similarly distinctive, 12 volunteers (6 male, 6 female, aged 18-27 years old) rated each face on a 5 point scale (1 = “not at all distinctive”, 5 = “extremely distinctive”). A mixed 2 (participant gender) x 2 (face age) x 2 (face gender) ANOVA revealed no significant main effects or interactions, ( $F < 1$  for all) suggesting no differences in distinctiveness for the facial stimuli used for the different ages, genders and combinations of the two factors.

For ease of interpretation, the gender of the facial stimuli was classified into own and other gender groupings, meaning that responses to male faces were classified as “own gender” responses for male participants and “other gender” for female participants (and vice versa for female faces).

### 5.2.4. *Procedure*

For the initial learning phase, participants were presented with 32 upright photographs (16 from each age group, within which there were half from each gender) in a random order at a 3 second rate, using EPrime 2.0 (Psychology Software Tools). The participants were instructed to classify the faces according to either their gender or age group (depending on the group they had been assigned to) as quickly and as accurately as possible using the computer keyboard. Following the learning phase,

participants completed a five minute filler task. This was a simple digit span task taken from the Wechsler Adult Intelligence Scale-III (Wechsler, 1998). The subsequent recognition test followed the same procedure as in the first three experiments in this thesis.

### 5.2.5. Results

Since there was no effect of pose type on accuracy, data were collapsed across this variable for the purpose of analysis.

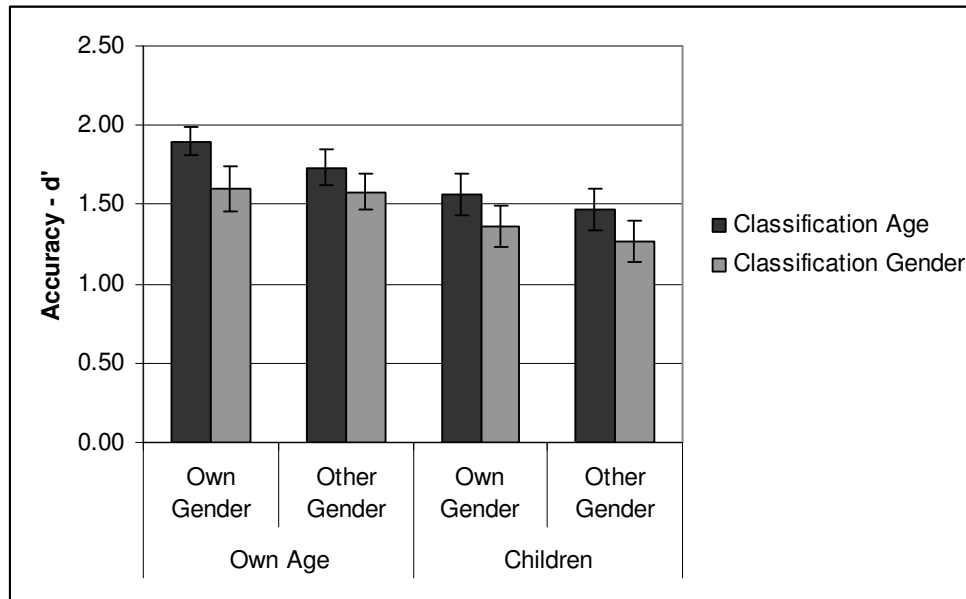
#### 5.2.5.1. Accuracy – Discriminability

Hit rates, false alarm rates, d-prime and c response bias scores were calculated to investigate accuracy and can be seen in Table 5.2.

**Table 5.2. Mean proportion of hits and false alarms, d' accuracy and c response criterion scores for the two categorisation groups**

Age Classification									
Photograph Age	Photograph Gender	Hit Rate		False Alarm Rate		Accuracy (d')		Response Bias (c)	
Own Age		Mean	SD	Mean	SD	Mean	SD	Mean	SD
	Own Gender	0.80	0.10	0.20	0.12	1.90	0.53	0.01	0.36
	Other Gender	0.77	0.12	0.21	0.13	1.73	0.66	0.04	0.35
Children									
	Own Gender	0.75	0.15	0.25	0.20	1.56	0.78	0.00	0.43
	Other Gender	0.74	0.16	0.27	0.19	1.47	0.75	-0.02	0.47
Gender Classification									
Photograph Age	Photograph Gender	Hit Rate		False Alarm Rate		Accuracy (d')		Response Bias (c)	
Own Age		Mean	SD	Mean	SD	Mean	SD	Mean	SD
	Own Gender	0.77	0.14	0.26	0.15	1.60	0.81	-0.04	0.36
	Other Gender	0.78	0.13	0.26	0.13	1.58	0.68	-0.07	0.33
Children									
	Own Gender	0.76	0.14	0.32	0.20	1.37	0.76	-0.12	0.46
	Other Gender	0.75	0.13	0.33	0.18	1.27	0.79	-0.13	0.34

Figure 5.2. shows the mean  $d'$  score for both categorisation groups for the own and other age and gender faces. Both groups appear to have been able to identify whether or not a face was familiar across all conditions at above chance levels ( $d' > 0$ ).



**Figure 5.2** The effect of face age and gender on mean  $d'$ -prime accuracy scores for the different categorisation groups (error bars show mean  $\pm 1$  standard error)

A 2 (group)  $\times$  2 (gender)  $\times$  2 (face age)  $\times$  2 (face gender) mixed ANOVA revealed a highly significant effect of face age ( $F(1,64)=11.99, p=.001, \eta_p^2=.16$ ) with increased accuracy for own-age faces (mean = 1.70, .07) compared to other-age faces (mean = 1.42, .08), consistent with an own-age bias in face recognition. There were no other significant main effects or interactions.

These results suggest that in terms of accuracy, both categorisation groups exhibited a significant own-age bias. However, Bonferroni corrected follow-up paired  $t$ -tests (corrected  $\alpha=.025$ ) showed that while this was true for the age categorisation group ( $t(33)=2.37, p<.025$ ), this pattern only reached nominal significance for the gender categorisation group ( $t(33)=2.09, p=.04$ ).

### 5.2.5.2. Accuracy – Response Bias

Figure 5.3. shows the mean  $c$  score for both experimental groups for the two face age stimulus conditions. As with the previous studies the  $c$  values were very close to 0, suggesting that there is very little response bias in this study. In fact, one-sample  $t$ -tests revealed that the magnitude of response bias only differed from 0 in the gender classification group for the other age, other gender faces ( $t(33)=-2.24, p<.05$ ).

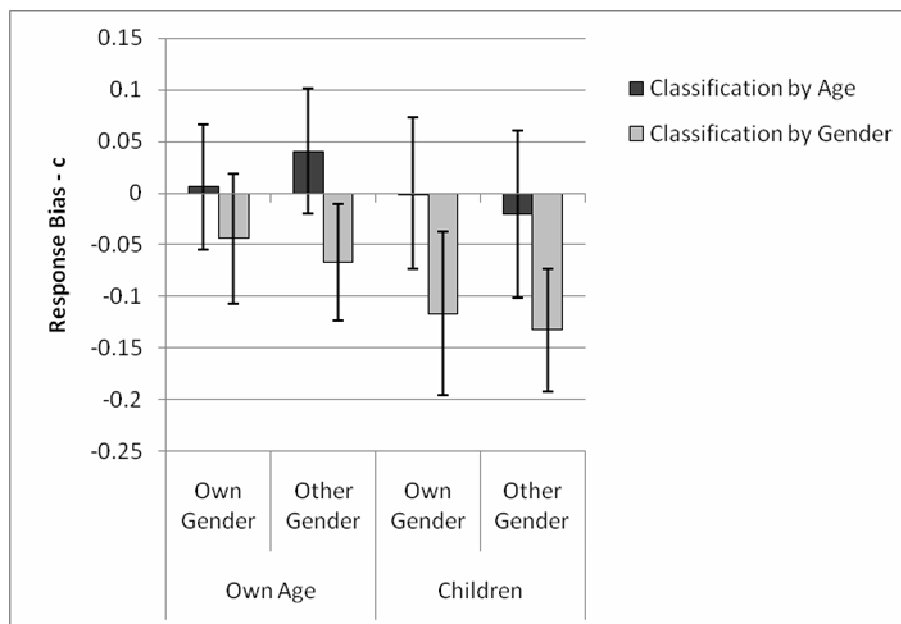


Figure 5.3 The effect of face age and gender on  $c$  response bias scores for the different categorisation groups (error bars show mean  $\pm 1$  standard error)

A 2x2x2 mixed ANOVA revealed no significant main effects or interactions (largest  $F=2.55$ ).

### 5.2.5.3. Latency

To minimize the variability often found in reaction time (RT) data, particularly long RTs were adjusted using the method described in the previous experiments. 2.1%



of the age classification and 2.3% of the gender classification group's responses were replaced in this way. Corrected mean RTs are shown in Figure 5.4.

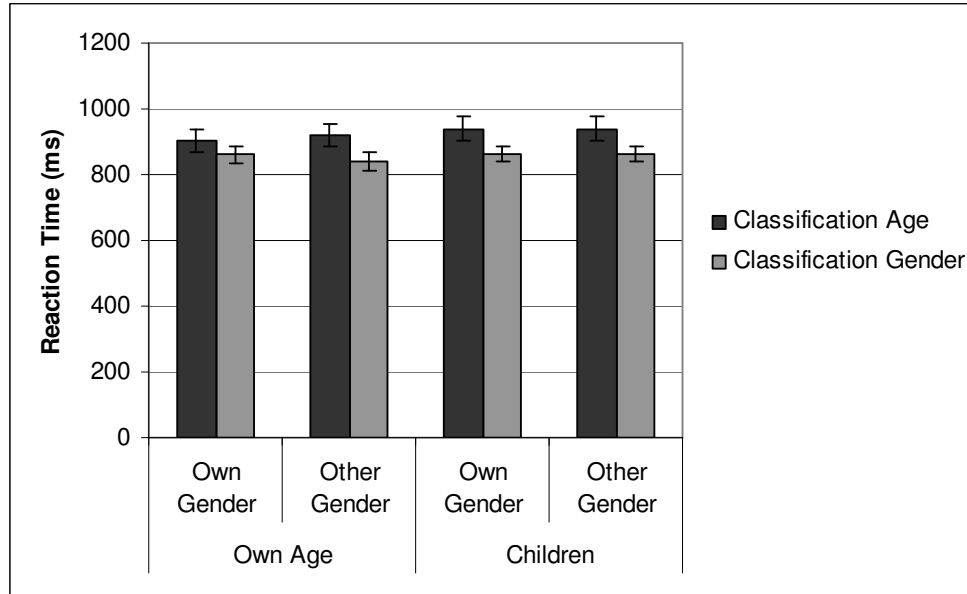


Figure 5.4 Mean reaction times for correct responses for the different face age and gender stimuli for both categorisation groups (bars show mean  $\pm$  1 standard error).

The four-way mixed ANOVA for reaction time data revealed a significant main effect of face age ( $F(1,64)=4.96$ ,  $p<.05$   $\eta_p^2=.07$ ) with participants performing significantly faster for own-age faces (mean=881.41, 21.55) than other-age faces (mean=901.54, 20.92). As with the accuracy data, no additional main effects or interactions were found (largest  $F=2.42$ ).

These results suggest that in terms of reaction time data, both categorisation groups exhibited an own-age bias. However, when investigated using Bonferroni corrected follow-up t-tests, only a nominally significant own-age bias was only found in the age categorisation condition (age categorisation:  $t(33)=-2.10$ ,  $p<.05$ ; gender categorisation condition:  $t(33)=-1.13$ ,  $ns$ ), but this did not survive Bonferroni correction.

#### 5.2.5.4. Classification Data

Figure 5.5. shows the mean classification reaction times for the two experimental groups. Individual paired t-tests revealed a significant other-group classification advantage for both the gender ( $t(33)=-2.19, p<.05$ ) and age ( $t(33)=-3.06, p<.01$ ) classification groups. That is, participants in both conditions were faster at classifying faces as being out-group members than they were at classifying in-group membership.

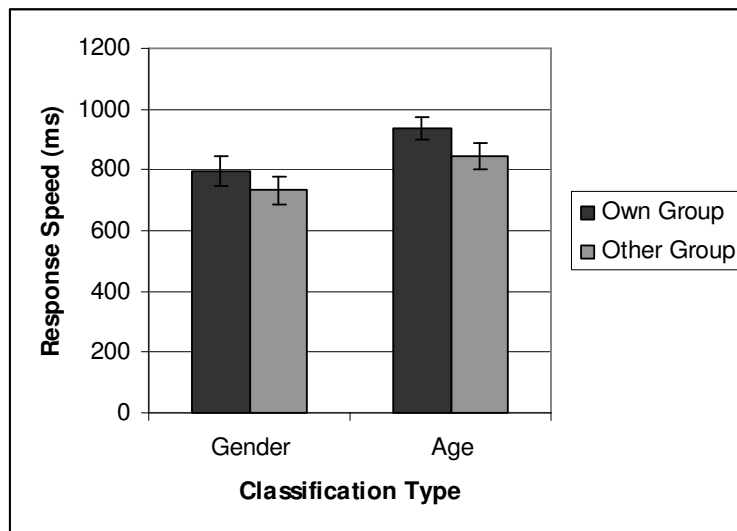


Figure 5.5 Mean reaction times for classification responses for in- and out- group faces (error bars show mean  $\pm 1$  standard error).

To assess whether the observed other-group classification advantages were related to the degree of own-group bias, separate indices were created. Firstly, a classification advantage score was calculated for each participant, by subtracting the response speed for other-group faces from that for the own-group faces, so that a larger number indicated a larger other-group classification advantage. In addition, own-group bias scores were calculated for each participant by subtracting their  $d'$  accuracy score

for other-group faces from that for the own-group faces. In this case, a larger number represented a large own-group bias in face recognition accuracy. A similar own-group bias index was created using reaction times, however in this case larger biases were represented by smaller numbers (specifically, more negative numbers). If the own-group classification advantage is indicative of the own-group bias magnitude, then one would expect to see a significant correlation between these measures. However this was not the case. Pearson correlations revealed no significant relationships (largest  $r = 0.13$ ).

### **5.3. Discussion**

This study found that overall participants exhibited an own-age bias in face recognition, regardless of the categorisation group into which they were placed (both in terms of accuracy and reaction time). However, when broken down into analyses for the two categorisation groups, a significant own-age bias was only exhibited for the age categorisation group in terms of accuracy. These results alone give mixed support for a social categorisation explanation of the own-age bias: the lack of a face-age  $\times$  group interaction for either accuracy or reaction time data suggest that classification of a face according to a dimension other than age does not reduce the salience of the age cues. However, when broken down into individual follow-up tests, the own-age bias only holds true for the age-classification group (suggesting categorisation may have a role to play). These apparently contradictory findings are likely to be a product of the small sample size (and resultant loss of power) when the groups are separated out, and conservative corrections applied to the individual follow-up tests. Thus, in this case,

more sway may be given to the significant overall face age effects, and lack of group interactions.

What is most striking from these results, however, is that no evidence of an own-gender bias was found, not even when classification was according to own- or other- gender. These results are contrary to previous research that has found an own-gender bias in face recognition (e.g. Wright and Sladden, 2003) or classification effects according to other deliberately labelled in- and out- groups (Bernstein et al, 2007) according to socially salient categories. Based on these findings, it therefore appears unlikely that categorisation according to groups such as age and gender is likely to be responsible for the previously witnessed own-group biases.

The assumption that the own-age bias should have been diminished as a result of categorisation according to another dimension assumes that the processing of age may not occur (or occurs to a lesser extent) as a result of age cues being incongruent to the task (i.e. classifying gender). However, this may not be the case. In a recent event-related potential study investigating the implicit and explicit categorisation of age and gender, Wiese, Schweinberger and Neumann (2008) found that gender information was only processed when the task was dependent on gender categorisation. In contrast, age information appeared to be processed regardless of whether this categorisation was task-relevant or not. As such, it is possible that faces were still being processed according to own- or other-age regardless of the fact that the task at hand did not demand this. In this way, the lack of face-age x group interaction witnessed in this study does not necessarily provide evidence against a social categorisation account of the own-age bias, but may be due to the fact that participants were classifying faces according to age in both experimental groups.

Nevertheless, there is one fundamental problem with this study which makes it difficult to draw such conclusions; only undergraduate participants were included. Thus one interpretation of the overall own-age bias found above may be that the own-age faces in this study were somehow more distinctive or memorable than the children's faces. Although this is an unlikely explanation, as distinctiveness ratings for the different groups did not significantly differ from one another. In addition, the same stimuli were used in Experiment 4, in which some of the participants recognised the children's faces at a similar (or indeed a higher) level of accuracy to the own-age faces. This makes it unlikely that the own-age faces in the present experiment were somehow intrinsically easier to recognise. However, in order to draw firmer conclusions about the role of social categorisation in the own-age bias (or lack thereof), future research should aim to include two age groups of participants in order to obtain a full-cross over effect.

Although not central to any of the hypotheses, an additional finding of this study was that participants in the age categorisation group performed generally more accurately than the gender classification participants. Why this might be the case is unclear, however it may be that age classification requires slightly deeper processing than gender as the clues to age may be more subtle than the cues to gender. For example, while subtle cues contained in the skin surface texture are central to age perception (e.g. George & Hole, 2000), perception of gender relies on broader, more noticeable facial cues (e.g. facial hair, eyebrows, jaw line). Indeed, the idea that age categorisation may involve deeper processing certainly seems to be reflected in the classification reaction times (see Figure 5.5) where age classifications were noticeably slower than those made for gender.

The hypothesis that classification of out-group members would be faster than classification of in-group members was supported. However, this other-group classification advantage did not appear to be significantly related to the degree of own-group bias exhibited. As such these findings do not directly support a specific feature-processing account of the own-age bias, similar to that offered by Levin (1996; 2000) for the own-race bias, as this would predict a significant relationship between the two phenomena.

It is difficult to conclude exactly what role social categorisation plays in the own-age bias. The finding that other-group members are classified faster than in-group members, and the fact that the own-age bias was not significant for the own-gender classification participants in terms of the reaction time data, suggest that social grouping may play a slight role in this effect. However there is more evidence against such an account than there is for it. Instead, it might be worth considering what other cognitive mechanisms might be at play, indeed it may be that these biases arise from a combination of social-cognitive mechanisms.

One of the most prevalent explanations of own-group biases (and one that will be directly addressed in the following chapter) is that of a perceptual expertise account. Essentially this is a perceptual learning account that suggests that through experience with faces belonging to our own in-group, we establish enhanced perceptual processing skills for these types of faces. Social in- and out-group classifications are likely to drive the experience we subsequently have with such faces (e.g. Tajfel, Billings, Brundy & Flament, 1971; Sporer, 2001), thus such an account still has room for social classification processes.

In terms of this study, if a perceptual expertise account was likely to offer a suitable explanation of the own-age bias, then one might expect to see an own-age bias in face recognition regardless of the initial categorisation strategy. This is because we tend to spend more time with, and have more social interest in, faces belonging to our own age group, while, generally speaking, we have a similar amount of experience with both genders. Indeed this pattern seems to be more reflective of the above results. Thus such an account may be applicable to the own-age bias. As such, the next chapter will address the role of perceptual expertise in the own-age bias.

## Chapter 6

### 6.1. Introduction

As adults, we are experts at face recognition. However there are some faces which we are more expert at recognising than others. For example, over four decades of research has demonstrated that we are better at recognising faces belonging to our own racial group compared to those of a different, less familiar race (see Meissner & Brigham, 2001). While this “own-race bias” is probably one of the best replicated phenomena in the face recognition literature, the reasons why it occurs are less clear. Perhaps the best known explanation of this effect is an experience-based account. That is, we tend to be better at recognising own-race faces as a result of the fact that we have relatively more experience with these faces. This type of explanation has received support from research showing that the own-race bias can be temporarily eliminated following a couple of hours of training with other race faces (e.g. Elliott, Wills & Goldstein, 1973; Malpass, Laviguer & Weldon, 1973; Hills & Lewis, 2006) and even reversed when we experience a large amount of exposure to other-race faces in childhood (Sangrigoli, Pallier, Argenti, Ventureyra & de Schonen, 2005).

More recently researchers have shown differences in the recognition ability for other groups of faces with which we have differential experience: different age groups. This thesis, as well as previous research, has suggested that we are better at recognising own-age faces compared to those belonging to another age group (see Chapter 2 and Section 1.7 for a review). This “own-age bias” has been found in both adults (e.g. Wright & Stroud, 2002) and children (e.g. Anastasi & Rhodes, 2005). Similar to



research on the own-race bias, it has been suggested that this difference in recognition performance may be the result of the differential (recent) experience we have with different age groups (e.g. Harrison & Hole, 2009; Kuefner et al, 2008). However, what is less clear is how this contact may result in these differing levels of recognition performance; specifically, with regard to what mechanisms may underlie this effect.

In terms of the own-race bias, the most commonly cited account of the memory advantage for own-group (i.e. own-race) faces is the perceptual expertise hypothesis (e.g. Rhodes et al, 1989). The crux of this explanation is that the relatively increased experience we have with own- compared to other- race faces leads to the development of more proficient processing strategies for them. Exactly what these strategies may be is still a heavily debated issue, however the most prevalent proposition in the literature suggests that this increased exposure to own-race faces leads to more expert processing of those faces. As configural processing is thought to be at the heart of expert face processing (e.g. Diamond & Carey, 1986; Gauthier & Tarr, 1997), it may be that same-race faces are processed in a more efficient, configural manner than other-race faces. One paradigm that has been used repeatedly to illustrate the relationship between configural processing and expertise is that of the inversion effect (Yin, 1969; see Section 1.2.). In their seminal study on the effects of expertise, Diamond and Carey (1986) showed that dog experts' ability to recognise dogs was affected by inversion to a similar extent as faces. In contrast, dog novices showed the typical disproportionate effect of inversion for faces. As such, they concluded that the more expertise one has with a class of stimuli, the more inversion disrupts the processing of that stimuli as a result of heavy reliance on configural processing for those objects of expertise. Recently Diamond and Carey's (1986) results, and accordingly their expertise

hypothesis, have been cast into doubt (e.g. Robbins & McKone 2007; McKone & Robbins, 2007). Nevertheless some additional studies have found evidence that inversion effects can be affected by expertise (e.g. Bruyer and Crispeels, 1992; Gauthier et al, 2000; Gauthier & Bukach, 2007; Rossion et al, 2002).

Therefore, if the own-race bias is the result of greater expertise with own-race faces, one would expect to see the recognition of these faces impaired to a greater extent than those of another race when turned upside-down. This has been found to be the case (Rhodes et al, 1989; Sangrigoli & de Schonen, 2004). Indeed this configural-expertise account has also gained support from studies that have shown that own-race faces are processed less holistically than other race faces, as demonstrated by differential composite and part-whole face effects (e.g. Michel, Caldara & Rossion, 2006; Michel et al, 2006; Tanaka et al, 2004, see Section 1.8.1.2. for further discussion of this).

In terms of the own-age bias in face recognition, little research has been carried out investigating the potential perceptual/cognitive mechanisms that may be responsible for producing such an effect. When Experiments 6 and 7 were carried out, only one such study had attempted to explore this issue. Following the same logical arguments used to try to explain the own-race bias, Perfect and Moon (2005) sought to investigate the effect of inversion on young- and older- adult faces with similarly aged participants. While a perceptual-expertise account of this effect would predict a greater disruption of own-age compared to other-age face recognition following inversion, the opposite pattern was in fact observed. This pattern of results is difficult to explain (particularly without reaction time data available to gain a fuller picture of the participants' behaviour), although it is of note that the authors made no attempt to control for the

experience participants had with other-age groups. Thus, it is possible that differential other-age experience may account for such findings.

In a more recent study, Kuefner et al (2008) investigated the role of expertise in other-age face recognition by looking at the effect of inversion on own-age faces and children's faces with teachers (other-age experts) and undergraduates (other-age novices). Novices exhibited the classic own-age bias for upright faces, but this difference disappeared when the faces were inverted. Notably, the inversion cost (percentage decrease in accuracy following inversion) to own-age faces was about double that for children's faces. For the expert group no own-age bias was present in upright faces and inversion affected both groups of faces equally. In contrast to Perfect and Moon's findings, these results directly support a perceptual-expertise account of the own-age bias. However it should be noted that the age of the teachers who took part in this study (24-56 years old) was not successfully matched to the "own-age" faces viewed (20-30 years old). The latter pattern may therefore be the result of participants in effect viewing two other-age face groups.

Thus, the only two studies investigating the effects of inversion on own- and other- age faces have yielded inconsistent results. As such, the primary aim of this chapter was to establish which of these two studies is likely to best represent the processes involved in the own-age bias in face recognition. Specifically, Experiments 6-8 sought to establish whether this bias is likely to be the result of enhanced perceptual expertise for own-age faces.

## 6.2. Experiment 6

An inversion paradigm was used to investigate whether a perceptual-expertise account, similar to that offered for the own-race bias (e.g. Rhodes et al, 1989), may offer an appropriate explanation of the own-age bias..

### 6.2.1. Design

A mixed design was used, with one between subjects variable: group (three levels: children; adults with high contact with children; and adults with low contact with children) and two repeated measures variables: age of photograph (two levels: child – 8-11 years old and young adult – 18-25 years old) and orientation (two levels: upright and inverted faces). The dependent variables of interest were accuracy ( $d'$ ) and response bias ( $c$ ) scores and response times (RTs).

### 6.2.2. Participants

There were 96 participants in total, including 32 children (mean age 8.75, SD .44, range 8-9 years, 17 girls, 15 boys), 32 in the high contact group (mean age 23.44, SD 2.12, range 21-28 years, 25 female, 7 male) and 32 in the low contact group (mean age 20.66, SD 2.06, range 18-27 years, 20 female, 12 male). Young adult participants were all students from the University of Sussex. The high contact group comprised trainee teachers on the primary PGCE or GTA courses who were paid £5 for their participation, while the low contact group were psychology students who received research credits for their participation. The children were all recruited from Year 4 at Goldstone Primary School in Hove after obtaining parental consent.

### 6.2.3. *Materials*

Photographs of 64 Caucasian males were taken. Half were between 8-11 years old, and half were between 18-25 years old. All of the people in the photographs were recruited from outside of Sussex to avoid any of the faces being accidentally familiar. The children's pictures were obtained with parental consent and were taken at Malvern Wells Church of England Primary School in Worcestershire. The adult male faces were obtained from students at Leeds University. Two photographs were taken of each individual, one in a smiling pose and the other neutral. All photographs were close up, frontal face images without glasses, jewellery, facial hair or other identifying features. Each photograph was then converted to greyscale and edited to a standard size (300 x 350 pixels) using Adobe Photoshop software. The background of each picture and any information outside of the head outline and the contour of the chin were removed and made solid white. For all faces, both upright and inverted (upside-down) versions of the stimuli were created.

### 6.2.4. *Procedure*

For the initial learning phase participants were presented with 32 upright photographs (16 from each age group) in a random order at a 3 second rate, using Superlab 2.01. The participants were instructed to try and remember the faces as best they could, as they would later be asked to identify them. Following the learning phase, participants completed a three minute filler task. This was the F-A-S verbal fluency task (Benton & Hamsher, 1977), where participants were given a minute per letter to name as many words as possible that begin with either F, A or S. This particular task

was chosen as it was thought to be of an appropriate level for both the adult and children participants.

This was followed by the recognition test which consisted of 64 photographs, 32 of which had previously been seen in their alternative pose during the learning phase (targets) and 32 of which were new (distractors). For both the target and distractor faces, half were presented in the upright position, while the other half were inverted. Photographs appeared in a different random order for each participant and were counterbalanced with respect to pose, old/new status and, in the recognition phase, orientation. Using the computer keyboard, participants were asked to indicate whether or not they recognised the individuals in the photos. A fixation dot was displayed in the centre of the screen for 500ms before each face appeared. The photographs appeared individually and the rate of presentation was determined by the participant's speed of response, with each face remaining on the screen until either a response was made or for a maximum of 2500ms.

#### 6.2.5. *Results*

Since there was no effect of pose type on accuracy, data were collapsed across this variable for the purpose of analysis.

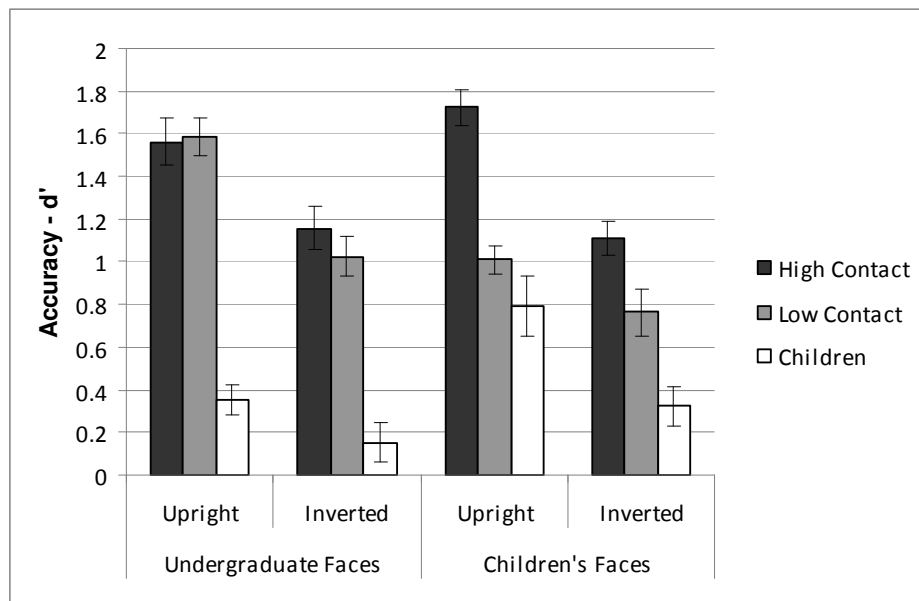
##### 6.2.5.1. *Accuracy – Discriminability*

Estimates of  $d'$  accuracy were calculated from the proportions of hits and false alarms investigated above. Table 6.1. shows the proportions of hits and false alarms,  $d'$  and response bias scores for the different participant groups. As with the previous chapters, in calculating  $d'$  a flattening constant was used (as in Wright & Sladden, 2003) so that  $z$  scores could be calculated when the hit or false alarm rate was either 0 or 1.

**Table 6.1. Mean proportion of hits and false alarms, d' accuracy scores and response bias scores**

<b>Upright Faces</b>									
<b>Participant Group</b>	<b>Photograph Age</b>	<b>Hit Rate</b>		<b>False Alarm Rate</b>		<b>Accuracy (d')</b>		<b>Response Bias (c)</b>	
<i>Children</i>		<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>
	Adult	0.58	0.13	0.45	0.14	0.35	0.39	-0.04	0.31
	Children	0.66	0.16	0.38	0.12	0.79	0.80	-0.06	0.19
<i>Low Contact Adults</i>									
	Adult	0.82	0.10	0.29	0.11	1.59	0.51	-0.20	0.29
	Children	0.69	0.10	0.31	0.10	1.01	0.37	0.01	0.21
<i>High Contact Adults</i>									
	Adult	0.80	0.12	0.28	0.07	1.56	0.62	-0.17	0.25
	Children	0.81	0.09	0.23	0.08	1.72	0.47	-0.07	0.25
<b>Inverted Faces</b>									
<b>Participant Group</b>	<b>Photograph Age</b>	<b>Hit Rate</b>		<b>False Alarm Rate</b>		<b>Accuracy (d')</b>		<b>Response Bias (c)</b>	
<i>Children</i>		<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>
	Adult	0.49	0.15	0.44	0.18	0.15	0.54	0.11	0.40
	Children	0.54	0.15	0.42	0.12	0.32	0.53	0.05	0.24
<i>Low Contact Adults</i>									
	Adult	0.68	0.12	0.32	0.12	1.02	0.53	0.00	0.27
	Children	0.60	0.12	0.33	0.15	0.76	0.62	0.12	0.27
<i>High Contact Adults</i>									
	Adult	0.70	0.14	0.29	0.12	1.16	0.58	0.01	0.30
	Children	0.69	0.13	0.29	0.10	1.11	0.43	0.04	0.27

Figure 6.1. shows the mean d' score for both experimental groups for all stimulus conditions. While both adult groups appear to have been able to identify whether a face was familiar or not across all conditions at above chance levels ( $d' > 0$ ), children performed close to chance levels in all but the upright child's face condition. One-sample t-tests revealed that for inverted young adult faces they were not performing significantly differently from chance levels ( $t(31)=1.61, p=.12$ ). With this in mind, one should be cautious when interpreting the children's results in this study.



**Figure 6.1** The effect of face age and orientation on mean d-prime accuracy scores for the different contact groups (error bars show mean  $\pm 1$  standard error)

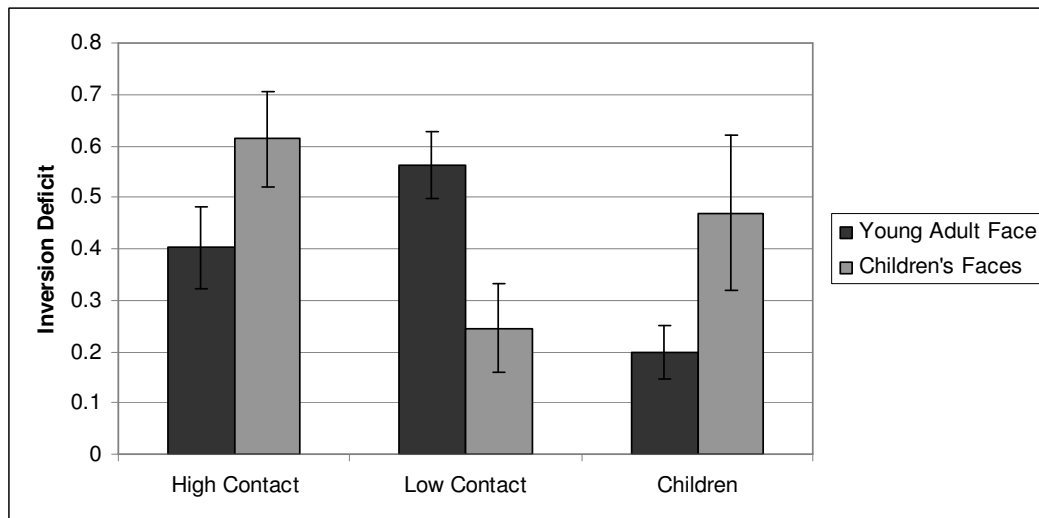
A 3 (group)  $\times$  2 (face age)  $\times$  2 (orientation) mixed ANOVA showed that while there was no significant main effect of face age ( $F < 1$ ), there was a significant main effect of inversion ( $F(1,93)=119.18, p < .001, \eta_p^2 = .56$ ). There was also a significant main effect of group on accuracy scores ( $F(2,93)=54.81, p < .001, \eta_p^2 = .54$ ). Post hoc Bonferroni tests revealed that this was as a result of the children performing significantly worse than both of the adult groups ( $p < .001$  in both cases) and due to the high contact adult group performing significantly more accurately than the low contact adult group ( $p < .01$ ).

There were also a couple of higher order interactions. Face age significantly interacted with group ( $F(2,93)=13.84, p < .001, \eta_p^2 = .23$ ) with those in the low contact group performing more accurately for young adult faces (mean = 1.30, .59) than the children's faces (mean = .89, .52), while children (young adult face mean = .25, .48;



children's face mean = .56, .71) and the high contact group (young adult face mean = 1.36, .63; children's face mean = 1.42, .55) showed the opposite pattern.

A significant three-way interaction between group, face age and orientation was also observed ( $F(2, 93)=5.97, p<.01, \eta_p^2=.11$ ) and is illustrated in Figures 6.1. and 6.2. Figure 6.2. shows the magnitude of inversion deficit ( $d'$  accuracy for upright faces minus  $d'$  accuracy for inverted faces) for all face ages. From the graphs it appears that while the low contact group show a larger inversion deficit for young adult faces than children's faces, the children and the high contact group show the opposite pattern.



**Figure 6.2** The effect of face age on the magnitude of the inversion effect for the different contact groups (bars show  $\pm 1$  standard error and measurements are in terms of  $d'$ )

Bonferroni corrected paired t-tests carried out on the inversion deficit scores revealed a significant effect of face age for the low contact group ( $t(31)=2.88, p<.01$ ) with participants showing a significantly larger inversion deficit for faces of their own age group. In contrast, the high contact group and the children showed no significant effect of face age ( $t(31)=-1.82, p=.08$ ;  $t(31)=-1.65, p=.11$  respectively).

Separate one-way ANOVAs showed that while the inversion deficit for the children's faces was similar for all three groups ( $F(2, 70.95)=2.64, p=.08, \eta_p^2=.05$ ),

there was a significant effect of group on the inversion deficit scores for young adult faces ( $F(2, 93)=7.49, p<.001, \eta_p^2=.14$ ). Bonferroni post-hoc tests revealed that this was as a result of the children having a significantly smaller inversion deficit than the low contact group ( $p<.001$ ).

A further hypothesis of this study was that if the own age bias is mediated by expertise and can therefore be characterised by an ability to efficiently use the configural cues in the faces, then the own-age bias (as indexed by the group x face age interaction) should only be present when faces are in the upright position. As inversion disrupts the configural information of the face, the effects of expertise should be eliminated when the faces are presented in the upside-down orientation. To investigate this specific hypothesis and to further analyse the above 3-way interaction, separate ANOVAs were carried out for the upright and inverted stimuli.

#### 6.2.5.1.1. *Upright Trials*

The two-way mixed ANOVA on accuracy scores for upright faces found no effect of face age ( $F<1$ ), however there was a main effect of group ( $F(2, 93)=47.45, p<.001, \eta_p^2=.51$ ) which Bonferroni post-hoc tests revealed was the result of the high contact group performing significantly better than the low contact group ( $p<.01$ ), who were in turn more accurate than the children ( $p<.001$ ). In addition, and consistent with the own-age bias there was a significant face age x group interaction ( $F(2, 93)=22.23, p<.001, \eta_p^2=.32$ ). As illustrated in Figure 6.1., follow up paired t-tests with Bonferroni correction (new  $\alpha=.017$ ) revealed that this significant interaction was due to the low contact group performing significantly more accurately with young adult faces than children's faces ( $t(31)=5.35, p<.001$ ), while the children showed the opposite pattern

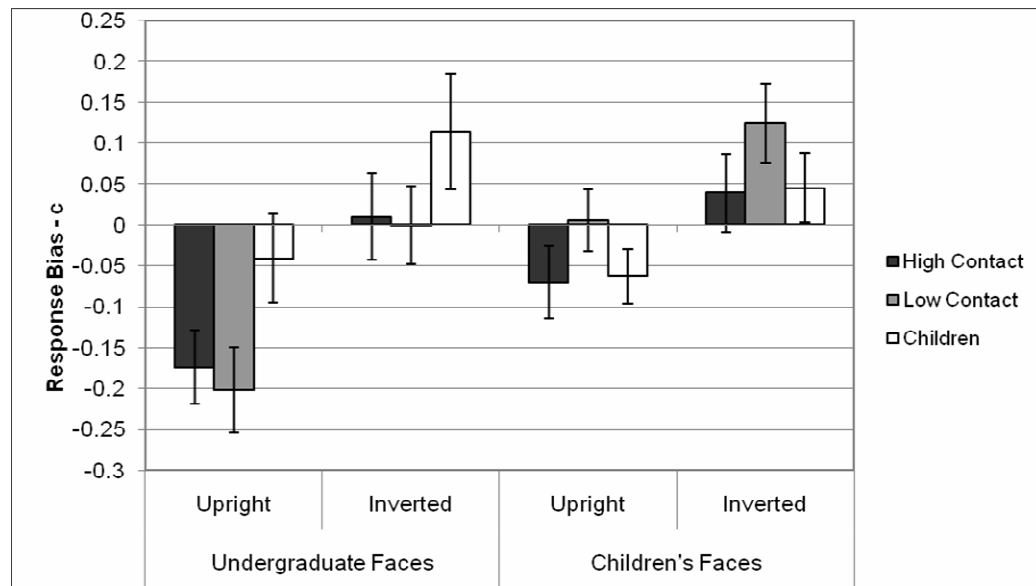
( $t(31)=-3.14, p<.01$ ) and the high contact group showed no significant difference in their performance for the two facial stimuli groups ( $t(31)=-2.10, p<.05$ ).

#### 6.2.5.1.2. *Inverted Trials*

As with the upright trials the ANOVA revealed no effect of face age ( $F<1$ ), but a significant main effect of group ( $F(2, 93)=41.49, p<.001, \eta_p^2=.47$ ). In this case, Bonferroni post-hoc tests revealed that this effect was the result of the children performing worse than both of the adults groups ( $p<.001$ ), who performed similarly to one another ( $p>.05$ ). In contrast to the upright faces, no significant interaction between face age and group was found ( $F(2, 93)=2.89, p=.06, \eta_p^2=.06$ ).

#### 6.2.5.2. *Accuracy – Response Bias*

Estimates of response bias ( $c$ ) were calculated from the hit and false alarm rates and can be seen in Figure 6.3. As with the previous experiments, it is worth noting that the  $c$  values are very close to 0, suggesting that there is very little response bias in this study. In fact, one-sample t-tests revealed that the magnitude of response bias only significantly differed from 0 in the high contact group for the upright young adult faces ( $t(31)=-3.87, p=.001$ ); and in the low contact group for the upright young adult faces and inverted children's faces ( $t(31)=-3.89, p<.001$ ;  $t(31)=2.59, p<.05$  respectively). None of the observed biases for the children significantly differed from 0 ( $t$  range = -1.89 - 1.63).



**Figure 6.3** The effect of face age on *c* response bias scores for the three contact groups (error bars show mean  $\pm$  1 standard error)

A 3x2x2 mixed ANOVA revealed no significant effects of face age ( $F(1,93)=3.13, p=.08, \eta_p^2=.03$ ) or group ( $F < 1$ ), but a significant main effect of orientation was found ( $F(1,93)=80.20, p<.001, \eta_p^2=.46$ ) with responses to upright faces generally being more liberal (mean =  $-.08, .26$ ) than responses to inverted faces (mean =  $.06, .29$ ). Only one significant interaction was found between face age and orientation ( $F(1,93)=4.53, p<.05, \eta_p^2=.05$ ) such that while inverted faces produced similarly small conservative response biases for both young adult faces (mean =  $.05, .32$ ) and children's faces (mean =  $.07, .26$ ), young adult faces (mean =  $-.13, .29$ ) resulted in a more liberal response criterion than children's faces (mean =  $-.04, .22$ ) when the stimuli were upright. As with previous experiments it is difficult to interpret these findings confidently, due to the small magnitude of response bias patterns (i.e. none of the mean values fall outside  $c = \pm 0.20$ ) suggesting that these finding may not be all that meaningful.

### 6.2.5.3. Latency

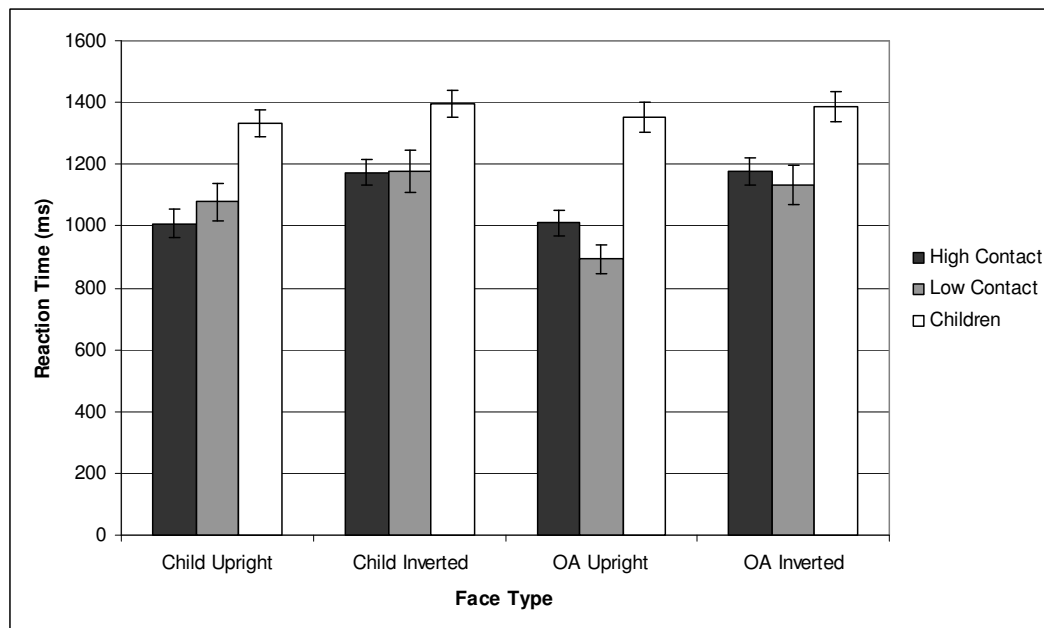
Mean RTs for correct responses were entered into a mixed 3 x 2 x 2 ANOVA with group, face age and orientation as variables of interest. This revealed significant main effects of face age ( $F(1,93)=4.20$   $p<.05$ ,  $\eta_p^2=.04$ ), orientation ( $F(1,93)=56.58$ ,  $p<.001$ ,  $\eta_p^2=.38$ ) and group ( $F(2,93)=13.49$   $p<.001$ ,  $\eta_p^2=.23$ ), which Bonferroni post-hoc tests revealed was due to the children performing slower than both of the adult groups ( $p<.001$ ), who performed similarly to one another ( $p>.05$ ). The pattern of main effects is illustrated in Figure 6.4.

There were also a number of higher order interactions. Face age significantly interacted with group ( $F(2,93)=4.94$ ,  $p<.01$ ,  $\eta_p^2=.10$ ) with those in the low contact group responding faster for young adult faces (mean = 1013.74, 347.33) than for the children's faces (mean = 1128.02, 350.76), while children (young adult face mean = 1368.75, 278.70; children's face mean = 1364.28, 249.00) and the high contact group (young adult face mean = 1092.73, 262.67; children's face mean = 1091.12, 268.63) responded at a similar speed for both ages of face.

In addition, there was an interaction between orientation and group ( $F(2,93)=5.50$ ,  $p<.01$ ,  $\eta_p^2=.11$ ) with both adult groups responding faster to upright faces than inverted faces (High Contact Group: upright mean = 1009.16, 260.88; inverted mean = 1174.72, 243.27; Low Contact Group: upright mean = 985.75, 304.99; inverted mean = 1156.01, 377.56) and the children responding at a similar speed to both (upright mean = 1342.41, 263.79; inverted mean = 1390.62, 262.53). The reason for this latter pattern is unclear, although it is of note that while carrying out the study, it appeared that there were often time lags and inconsistencies between when a child made a

decision about the familiarity of a face and when they made the appropriate response. This is believed to be an issue, as the children often verbally commented on whether or not they recognised a face before pressing the corresponding button. As such, reaction time data may not be all that reliable for this group.

Finally, a significant three-way interaction between group, face age and orientation was also observed ( $F(2, 93)=3.58, p<.05, \eta_p^2=.07$ ) and is illustrated in Figure 6.4. As with  $d'$  scores, inversion deficit scores were calculated (RT upright – RT inverted) and analysed. Bonferonni corrected paired t-tests revealed a nominally significant effect of face age for the low contact group ( $t(31)=2.28, p<.05$ ) with participants showing a significantly larger inversion deficit for faces of their own age group, however this finding did not survive the Bonferroni corrected alpha level ( $\alpha=.017$ ). In addition, the high contact group and the children showed no effect of face age ( $t(31)=.04, p=.97$ ;  $t(31)=-.71, p=.49$  respectively).



**Figure 6.4** Mean reaction times for correct responses for the different face age stimuli for both age groups (bars show mean  $\pm 1$  standard error).

As with accuracy, analysis was separated for the upright and inverted trials in order to further investigate the three-way interaction.

#### 6.2.5.3.1. *Upright Trials*

The two-way mixed ANOVA on accuracy scores for upright faces found a significant main effect of face age ( $F(1, 93)=7.54, p<.01, \eta_p^2=.08$ ), with young adult faces (mean = 1085.27, 327.59) being correctly responded to faster than children's faces (mean = 1139.61, 312.71). In addition, there was a main effect of group ( $F(2, 93)=19.35, p<.001, \eta_p^2=.29$ ) which Bonferroni post-hoc tests revealed was the result of the children performing significantly slower than both of the adult groups ( $p<.001$ ) who did not significantly differ in overall response speed ( $p>.05$ ). In addition, and consistent with the own-age bias there was a significant face age x group interaction ( $F(2, 93)=10.68, p<.001, \eta_p^2=.19$ ). Follow up Bonferroni corrected paired t-tests revealed that this was due to the low contact group performing significantly faster with young adult faces ( $t(31)=4.03, p<.001$ ) while the high contact group and children showed no such pattern ( $t<1$  in both cases).

#### 6.2.5.3.2. *Inverted Trials*

Only one significant finding resulted from the ANOVA for the inverted trials, and that was for group ( $F(2, 93)=7.05, p<.01, \eta_p^2=.13$ ). Again, Bonferroni post-hoc tests revealed that this effect was the result of the children performing slower than both of the adults groups ( $p<.001$ ), who performed similarly to one another ( $p>.05$ ).

### 6.2.6. *Discussion*

Results from Experiment 6 showed that while both children (in terms of accuracy) and low contact adults (in terms of accuracy and RTs) exhibited an own-age bias for upright faces, high contact adults showed no own-age bias for either of the measures. However, once faces were inverted, no significant interactions between face age and group were found. This finding directly supports a perceptual-expertise account of the own-age bias.

In addition, the low contact adult groups exhibited a greater inversion impairment for own-age faces, with which they had more experience (although this only reached nominal significance in terms of latency). In contrast, the high contact adults showed no such pattern, which one would expect due to the high level of experience with both age groups. Again, these findings support a perceptual-expertise explanation of the own-age bias. However, it is of note that children did not exhibit a larger inversion deficit of own-age faces. This may be due to an increased reliance on featural processing in the age group which is less dependent on expertise and less effected by inversion (Mondloch et al, 2002).

An additional finding of this study was that children's accuracy was affected by inversion to a similar extent as adults' for children's faces. However when the faces were of undergraduate age, the children exhibited less of an inversion deficit than the undergraduate participants. This implies that past research with children suggesting that they process faces in a less configural manner than adults (e.g. Diamond & Carey, 1986) may have been underestimating their face processing abilities (as has also been suggested by Flin, 1985, and George, Hole & Scaife, 2000).



However, as noted above, the children's results in this study should be taken with caution, as  $d'$  analysis revealed that they were performing close to chance levels in all but the upright child's face condition. This may have been due to task difficulty. The study was originally designed for adult participants only, and thus the child group may have been disadvantaged. For example, the experimenter noted that in comparison to adults, children failed to respond to considerably more faces in the 2.5 second interval that they were given in which to indicate whether or not they recognised a face. This could easily have biased the results. In addition, this may go some way to explaining the lack of an inversion effect in the children's RTs. It is possible that the cut off time of 2500ms may have resulted in the loss of longer response latencies being recorded for this age group. Thus, in order to decrease task difficulty and to ensure all relevant data were recorded, Experiment 7 attempted to replicate this study, with the addition of longer face exposure times in the initial study phase and keeping the recognition phase faces on the screen until the participant made a response.

### **6.3. Experiment 7**

#### *6.3.1. Design*

The same experimental design was used as in Experiment 6.

#### *6.3.2. Participants*

There were 101 participants in total, however only the data from 99 participants were included in the analysis after 2 of the children had to be excluded for not following the instructions. Included in the final analysis were 32 children (mean age 9.84, SD .51, range 9-11 years), 34 adults in the high contact group (mean age 21.87, SD 2.34, range

19-28 years) and 33 adults in the low contact group (mean age 22.28, SD 2.88, range 19-29 years). Low contact participants were all psychology students from the University of Sussex who received research credits for their participation. High contact participants were initially recruited by emailing the PGCE and GTA courses. However, most of the volunteers had been involved with the previous study, and thus had to be excluded from taking part. Only 9 additional participants came forward from this group, and so recruitment had to take place in another way. The remainder of the high contact participants were recruited by emailing the Sussex subject volunteer pool requesting participants who had current occupational experience with primary school children. All members of this group were paid £5 for their participation. The children were all recruited from Years 5 and 6 at Somerhill Primary School in Hove after obtaining parental consent.

### 6.3.3. *Materials*

The same materials were used as in Experiment 6.

### 6.3.4. *Procedure*

The procedure was basically the same as Experiment 6, however some changes were made to the timing in order to make the study easier for the youngest age group. Only the following changes took place: the initial study time for the photographs was lengthened (times were increased by 1 second to 4 seconds) and in the recognition phase, faces always remained on the screen until a response was made. All other aspects of the procedure remained the same.

### 6.3.5. Results

Since there was no effect of pose type on accuracy, data were collapsed across this variable for the purpose of analysis.

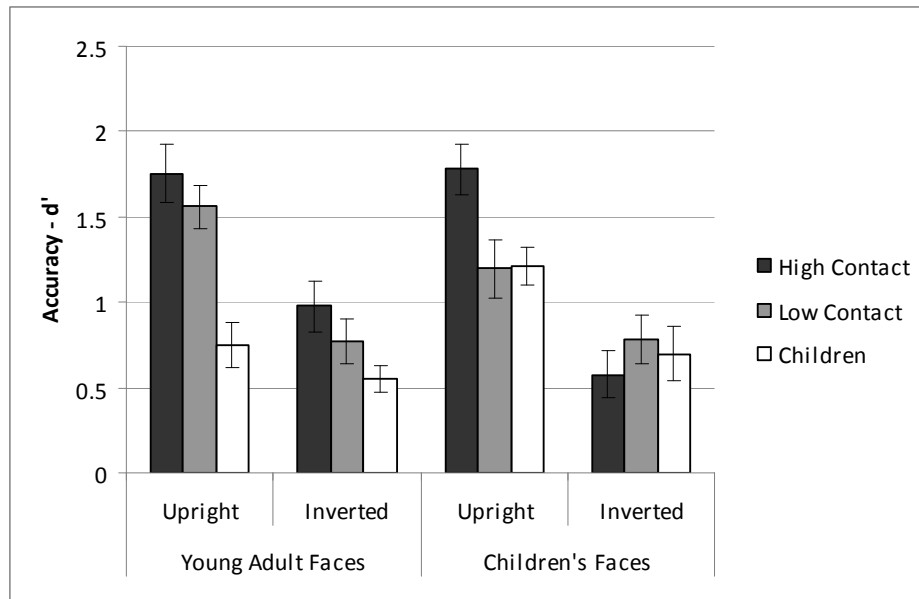
#### 6.3.5.1. Accuracy – Discriminability

Estimates of  $d'$  accuracy were calculated from the proportions of hits and false alarms. Table 6.2. below shows the hit and false alarm rates,  $d'$  and response bias scores for the different conditions. As before, a flattening constant was used to allow  $d'$  scores to be calculated when the hit or false alarm rate was either 0 or 1.

**Table 6.2 Mean proportion of hits and false alarms,  $d'$  accuracy scores and response bias scores**

Upright Faces									
Participant Group	Photograph Age	Hit Rate		False Alarm Rate		Accuracy ( $d'$ )		Response Bias (c)	
Children		<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>
	Adult	0.65	0.15	0.39	0.13	0.75	0.75	0.04	0.20
	Children	0.69	0.13	0.27	0.12	1.21	0.65	0.01	0.29
Low Contact Adults									
	Adult	0.77	0.12	0.23	0.13	1.56	0.74	0.01	0.22
	Children	0.72	0.15	0.31	0.18	1.20	0.96	0.07	0.19
High Contact Adults									
	Adult	0.83	0.14	0.27	0.16	1.75	0.96	0.19	0.24
	Children	0.80	0.13	0.22	0.12	1.78	0.84	0.03	0.20
Inverted Faces									
Participant Group	Photograph Age	Hit Rate		False Alarm Rate		Accuracy ( $d'$ )		Response Bias (c)	
Children		<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>
	Adult	0.62	0.10	0.41	0.10	0.55	0.44	0.03	0.15
	Children	0.62	0.16	0.38	0.16	0.70	0.90	0.01	0.15
Low Contact Adults									
	Adult	0.65	0.13	0.37	0.15	0.77	0.76	0.02	0.19
	Children	0.63	0.11	0.35	0.17	0.78	0.79	-0.05	0.20
High Contact Adults									
	Adult	0.70	0.18	0.35	0.14	0.98	0.84	0.08	0.26
	Children	0.59	0.15	0.38	0.14	0.58	0.76	-0.06	0.17

Figure 6.5. shows the mean  $d'$  score for both experimental groups for all stimulus conditions. All groups appear to have been able to identify whether a face was familiar or not across all conditions at above chance levels ( $d' > 0$ ).



**Figure 6.5** The effect of face age and orientation on mean  $d'$ -prime accuracy scores for the different contact groups (error bars show mean  $\pm 1$  standard error)

A 3x2x2 mixed ANOVA showed that while there was no main effect of face age ( $F < 1$ ), there was a significant overall inversion effect ( $F(1,96)=125.76, p < .001, \eta_p^2=.57$ ). There was also a significant main effect of group on accuracy scores ( $F(2,96)=5.07, p < .01, \eta_p^2=.10$ ). Post hoc Bonferroni tests revealed that this was due to the children performing significantly worse than the high contact group ( $p < .01$ ).

There were also a couple of higher order interactions. While orientation did not significantly interact with face age ( $F < 1$ ), it did interact with contact group ( $F(2,96)=10.13, p < .001, \eta_p^2=.17$ ) such that all groups performed with fairly similar

accuracy when the faces were upside down (high contact mean=.78, .82; low contact mean=.78, .77, children=.62, .71), however when the faces were upright the high contact group performed most accurately (mean=1.77, .89), followed by the low contact adults (mean=1.38, .87) followed by the children (mean=.98, .73). In addition, face age significantly interacted with group ( $F(2,96)=7.17, p<.001, \eta_p^2=.13$ ) with the children performing more accurately for children's faces (mean=.95, .82) than the young adult faces (mean=.65, .62), while the high contact (young adult face mean=1.37, .97; children's face mean=1.18, 1.00) and low contact group (young adult face mean=1.17, .84; children's face mean=.99, .90) showed the opposite pattern.

This was further qualified by a significant three-way interaction between group, face age and orientation ( $F(2,96)=3.81, p<.05, \eta_p^2=.07$ ) which is illustrated in Figures 6.5. and 6.6. Figure 6.6. shows the magnitude of inversion deficit ( $d'$  accuracy for upright faces minus  $d'$  accuracy for inverted faces) for all face ages. From the graphs it appears that while the low contact group showed a larger inversion deficit for young adult faces than children's faces, the children and the high contact group showed the opposite pattern.

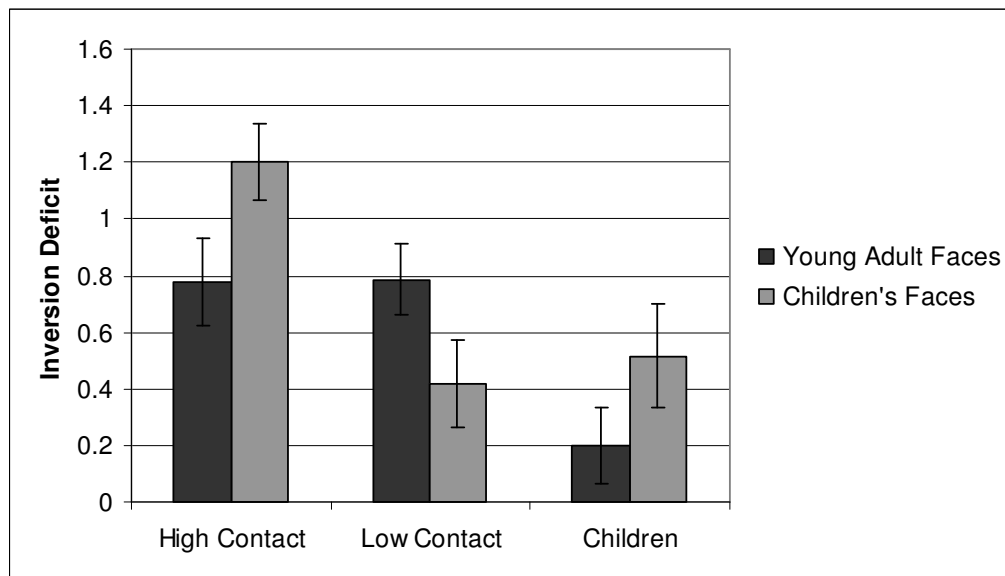


Figure 6.6. The effect of face age on the magnitude of the inversion effect ( $d'$  for upright faces minus  $d'$  for inverted faces) for the different contact groups (bars show  $\pm 1$  standard error)

Paired t-tests with Bonferroni corrections carried out on the inversion deficit scores revealed a nominally significant effect of face age for the high contact group ( $t(33)=-2.28, p<.05$ ) with participants showing a significantly larger inversion deficit for children's faces than for the young adult faces. However, this pattern did not survive the Bonferroni corrected alpha level ( $\alpha=.017$ ). In addition, neither the low contact group nor the children showed a significant effect of face age on their inversion deficit scores ( $t(32)=1.70, p=.10$ ;  $t(31)=-1.23, p=.23$  respectively).

Separate one-way ANOVAs showed that there was a significant main effect of group on the inversion deficit magnitude for both the young adult ( $F(2, 96)=5.62, p<.01, \eta_p^2=.11$ ) and children's faces ( $F(2, 96)=7.52, p=.001, \eta_p^2=.14$ ). Bonferroni post-hoc tests revealed that for young adult faces, this was due to the children having a significantly smaller inversion deficit than both adult groups ( $p=.01$  in both cases). For the children's faces, this was the product of the high contact group being more affected

by inversion than either the children or the low contact group ( $p < .01$ ) who showed similar inversion effects.

As with Experiment 6, this three-way interaction was further investigated to examine the hypothesis that the own age bias is mediated by expertise. Again, if the own age bias can be characterised by an ability to efficiently use the configural cues in the face, as associated with expertise, then the own-age bias (as indexed by the group x face age interaction) should only be present when faces are upright. As inversion disrupts the configural information of the face, the effects of expertise should be eliminated when the faces are inverted. Thus, separate ANOVAs were carried out for the upright and inverted faces.

#### 6.3.5.1.1. *Upright Trials*

The two-way mixed ANOVA on accuracy scores for upright faces found no effect of face age ( $F < 1$ ), but there was a main effect of group ( $F(2,96) = 10.97$ ,  $p < .001$ ,  $\eta_p^2 = .19$ ) which Bonferroni post-hoc tests revealed was due to the high contact group performing significantly better than the children ( $p < .001$ ). In addition, and consistent with the own-age bias there was a significant face age x group interaction ( $F(2,96) = 6.28$ ,  $p < .01$ ,  $\eta_p^2 = .12$ ). Follow-up Bonferroni corrected paired t-tests revealed that this significant interaction was due to the low contact group performing more accurately with young adult faces than with children's faces ( $t(32) = 2.07$ ,  $p < .05$ ), while the children showed the opposite pattern ( $t(31) = -2.51$ ,  $p < .05$ ). However, while these patterns were nominally significant, neither survived the Bonferroni corrected alpha level ( $\alpha = .017$ ). In addition, the high contact group showed no difference in terms of accuracy for the two sets of faces ( $t(33) = -.20$ ,  $p = .84$ ).

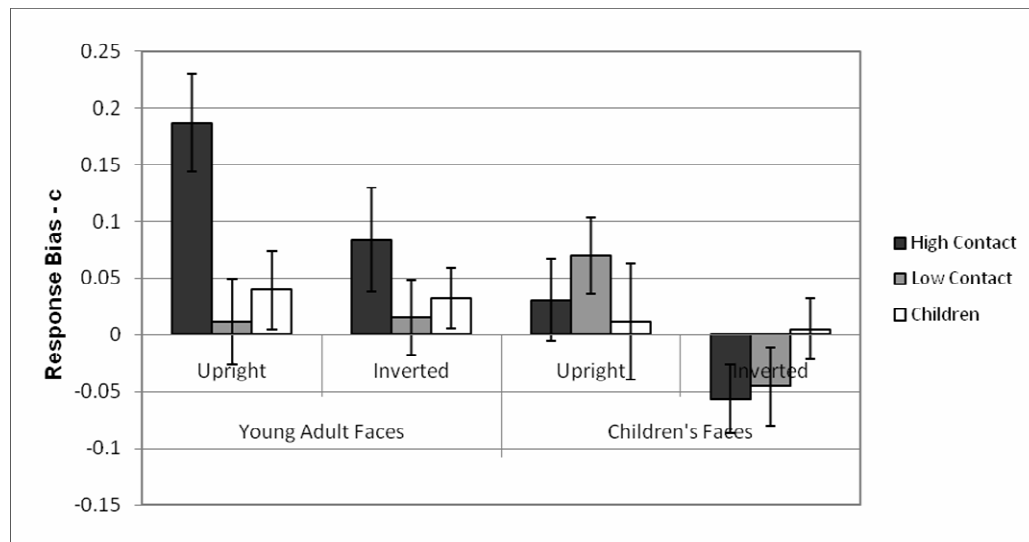
#### 6.3.5.1.2. *Inverted Trials*

As with the upright trials the 2 x 3 ANOVA revealed no effect of face age ( $F=1.10$ ). Although in this case there was also no effect of group ( $F<1$ ). However, a significant interaction between face age and group was found ( $F(2,96)=4.15, p<.05, \eta_p^2=.08$ ). Follow-up t-tests revealed no differences in accuracy for young adult or children's faces for either the low contact or children groups ( $t<1$  in both cases). However the high contact group were significantly more accurate with inverted young adult faces than with children's faces ( $t(34)=3.98, p<.001$ ). There is currently no explanation offered as to why this latter finding might have occurred. However it might be of note that while there was a significant difference in the high contact group's performance with adult and children's faces, when the group differences were analyzed within facial stimuli type, one-way ANOVAs revealed that there was no effect of contact group on accuracy for either children's ( $F<1$ ) or young adult faces ( $F(2,96)=3.00, ns$ ).

#### 6.3.5.2. *Accuracy – Response Bias*

Estimates of response bias ( $c$ ) were calculated from the hit and false alarm rates and can be seen in Figure 6.7.). As with the previous studies the  $c$  values were very close to 0, suggesting that there is very little response bias in this study. In fact, one-sample t-tests revealed that the magnitude of response bias only significantly differed from 0 in the high contact group for the upright young adult faces ( $t(33)=4.51, p<.001$ ), and in the low contact group for the upright children's faces ( $t(32)=2.13, p<.05$ ). None of the observed biases for the children significantly differed from 0 ( $t$  range=.20 - 1.23).





**Figure 6.7** The effect of face age on c response bias scores for the three contact groups (error bars show mean  $\pm$  1 standard error)

A 3x2x2 mixed ANOVA revealed a significant effect of face age ( $F(1,96)=9.66$ ,  $p<.01$ ,  $\eta_p^2=.09$ ) with responses to young adult faces (mean=.06, .22) generally being more conservative than those to children's faces (mean=.002, .21). A significant main effect of orientation was also found ( $F(1,96)=5.86$ ,  $p<.05$ ,  $\eta_p^2=.06$ ) with responses to upright faces generally being a bit more conservative (mean=.06, .23) than responses to inverted faces (mean=.006, .19). In this case, there was no significant effect of contact group ( $F(2,96)=1.63$ , *ns*).

Only one significant interaction was found. This was between face age and group ( $F(2,96)=5.79$ ,  $p<.01$ ,  $\eta_p^2=.11$ ) such that while the high contact group and children performed more conservatively for young adults faces (mean=.14, .25; mean=.04, .17 respectively) than children's faces (mean=-.01, .19; mean=.008, .23), the low contact group responded in a similar way to both types of stimuli (mean=.01, .20 for both face ages). As with the previous studies, finding meaning in these results is

difficult due to the small magnitude of response bias patterns (i.e. none of the mean values fall outside  $c=\pm 0.20$ ).

#### 6.3.5.3. Latency

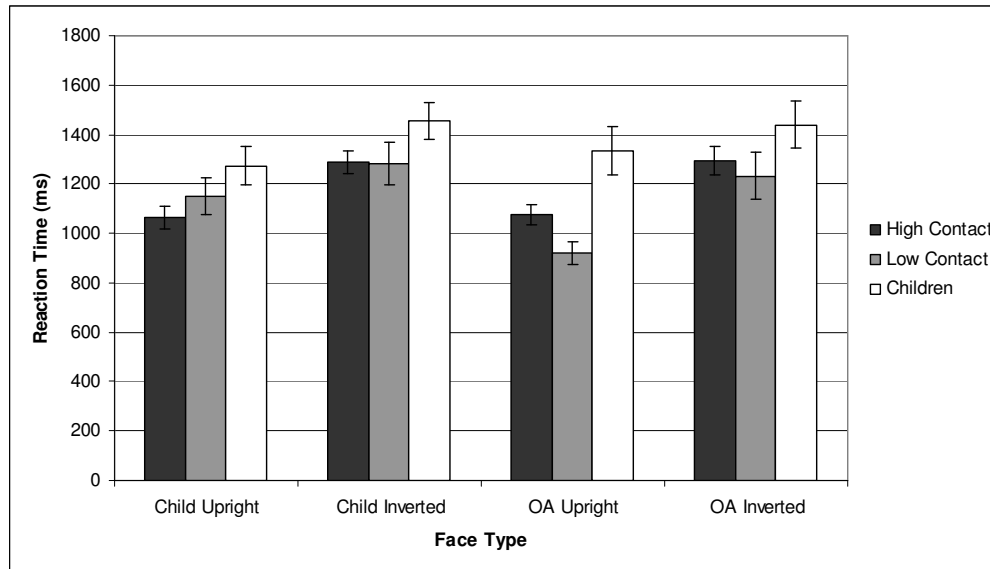
Mean RTs for correct responses were entered into a mixed 3 x 2 x 2 ANOVA with group, face age and orientation as variables of interest. No significant main effect of face age ( $F(1,96)=3.17$   $p=.08$ ,  $\eta_p^2=.03$ ) was found, however there was a significant inversion effect ( $F(1,96)=56.58$ ,  $p<.001$ ,  $\eta_p^2=.38$ ) with faster responses to upright faces (mean=1132.69, 399.69) than to inverted faces (mean=1329.86, 440.94). A significant effect of contact group was also found on reaction time ( $F(2,96)=3.62$   $p<.05$ ,  $\eta_p^2=.07$ ), which Bonferroni t-tests showed was due to the children responding more slowly than both of the adult groups ( $p<.05$ ), who performed similarly to one another ( $p>.05$ ). The pattern of main effects is illustrated in Figure 6.8.

There were also a couple of higher order interactions. Face age significantly interacted with group ( $F(2,96)=6.78$ ,  $p<.01$ ,  $\eta_p^2=.12$ ), with the low contact group performing faster with young adult faces (mean=1076.01, 447.52) than with the children's faces (mean=1215.98, 459.71), while children (young adult face mean=1386.13, 537.37; children's face mean=1362.51, 438.43) and the high contact group (young adult face mean=1184.05, 301.79; children's face mean=1174.80, 295.50) showed the opposite pattern.

This interaction was further qualified by a significant three-way interaction between group, face age and orientation ( $F(2,96)=4.05$ ,  $p<.05$ ,  $\eta_p^2=.08$ ), illustrated in Figure 6.8. As with  $d'$  scores, inversion deficit scores were calculated (RT upright – RT inverted) and analysed. Bonferroni paired t-tests revealed a nominally significant effect

of face age for the low contact group ( $t(32)=2.05, p<.05$ ) with participants showing a significantly larger inversion deficit for young adult faces than children's faces.

However, this pattern did not survive the Bonferroni corrected alpha level ( $\alpha=.017$ ). In addition, neither the children, nor the high contact group showed a difference in the magnitude of inversion deficit for the two sets of facial stimuli ( $t(31)=-1.69, p=.10$ ;  $t(33)=-.02, p=.98$ , respectively).



**Figure 6.8** Mean reaction times for correct responses for the different face age stimuli for the three contact groups (bars show mean  $\pm$  1 standard error).

As with accuracy, analysis was separated for the upright and inverted trials in order to further investigate the three-way interaction.

#### 6.3.5.3.1. Upright Trials

The two-way mixed ANOVA on accuracy scores for upright faces found a significant main effect of face age ( $F(1,96)=6.24, p<.05, \eta_p^2=.06$ ), with young adult faces (mean=1105.64, 407.14) being correctly responded to faster than children's faces (mean=1321.07, 473.64). In addition, there was a main effect of group ( $F(2,96)=5.17$ ,

$p < .01$ ,  $\eta_p^2 = .10$ ) which Bonferroni post-hoc tests revealed was due to the children responding significantly more slowly than both of the adult groups ( $p < .05$ ) who did not significantly differ in overall response speed ( $p > .05$ ). In addition, and consistent with the own-age bias, there was a significant face age x group interaction ( $F(2,96) = 17.22$ ,  $p < .001$ ,  $\eta_p^2 = .26$ ). Follow-up paired t-tests revealed that this significant interaction was due to the low contact group responding significantly faster with young adult faces ( $t(32) = 4.74$ ,  $p < .001$ ) than with children's faces. In contrast, children and the high contact group performed at a similar speed for both facial age groups ( $t(31) = -1.81$ ,  $p = .08$ ;  $t(33) = -.36$ ,  $p = .72$  respectively).

#### 6.3.5.3.2. *Inverted Trials*

No significant main effects or interactions were found for the inverted faces (all  $F$ 's  $< 1.02$ ). This is consistent with an expertise related account of the own-age bias in face recognition.

#### 6.3.6. *Discussion*

Experiments 6 and 7 both demonstrated that the low contact adult groups exhibited a greater inversion deficit for own-age faces, with which they had more experience, in terms of accuracy (in Experiment 6) and faster reaction times (in Experiment 7; reaching nominal significance in Experiment 6). Why these results are not consistent between experiments is unclear, although it is of note that trends in the expected direction were observed. As such, the use of a larger sample size may yield more consistent results in the future.

Inversion deficit scores for the children and high contact adult were not significantly different for the different stimuli ages. While no difference would be expected for the high contact group, due to high levels of experience with both facial age groups, one may have expected to see a larger deficit for own-age faces for children. However the absence of this finding may not serve as evidence against a perceptual-expertise account, but may instead be due to this age group's increased reliance on featural cues when recognising faces (Mondloch, Le Grand & Maurer, 2002).

In addition, while high contact adults performed similarly for both ages of facial stimuli, low-contact adults showed enhanced recognition accuracy (in Experiment 6) and faster reaction times (in both Experiment 6 and 7) for own-age faces when they were presented upright. However, this pattern was eliminated when they were presented upside-down. Children also exhibited this pattern in terms of accuracy in Experiment 6, although this was not replicated in Experiment 7 and did not extend to reaction time data (possibly because reaction times may not accurately represent performance in this age group, as discussed in Experiment 1).

These findings appear to lend some support to a perceptual-expertise account of the own-age bias. If the own age bias is mediated by perceptual expertise, it can be characterised by an ability to more efficiently use the configural cues in the faces with which we have more experience. As inversion disrupts the configural information of the face, then enhanced performance for own-age faces should only occur when faces are in the upright position, which was the case for the low-contact adults. While children only showed this pattern in terms of accuracy in Experiment 6, the lack of replication may be due to typically less developed configural processing abilities in this

age group (e.g. Mondloch et al, 2002). In accordance with perceptual-expertise theory, the high-contact group were not expected to exhibit an own-age bias due to high contact with both age groups used as stimuli.

However, inferring greater configural coding of own-age faces based on the elimination of the own-age bias after face inversion (as well as larger inversion decrements for own-age faces) may be problematic as this assumes that inversion selectively disrupts configural information (Diamond & Carey, 1986). This may not be the case, as previous studies have shown that inversion also impairs featural/component coding, albeit to a lesser extent (e.g. Mondloch et al, 2002). Thus the presence of an inversion effect may not simply reflect a disruption of configural processing, but may in fact be the result of “some unknown combination of impaired configural, component, and holistic coding” (Rhodes, Hayward & Winkler, 2006). As such, while it is fair to suggest that own-age faces are usually processed more efficiently than other-age faces as a result of differential experience, the results from these experiments do not necessarily shed light on the specific processing benefits that arise as a result of this expertise. In order to investigate this issue further, Experiment 8 sought to explore participants’ sensitivity to the configural information contained in own- and other- age faces.

As face experts, we are very sensitive to small changes made to the spatial configuration of the facial features (Friere et al, 2000; Haig, 1984; 1986; Hosie et al, 1988; Kemp et al, 1990; Leder et al, 2001; Mondloch et al, 2002). For example, Haig (1984; 1986) and Hosie et al (1988) demonstrated that we are able to detect changes to the positioning of the eyes, nose and mouth that are so slight that they are approaching the threshold of our visual acuity (corresponding to alternations of a magnitude as little

as approximately 4-6% of the inter-pupillary distance). Not only that, but more recent studies have shown that our ability to detect these changes (particularly those made to the position of the eyes and the nose) improves as a function of facial familiarity (e.g. Brooks & Kemp, 2007; O'Donnell & Bruce, 2001). Thus, if the own-age bias in face recognition is the result of perceptual expertise<sup>12</sup>, reflected in enhanced configural processing for own-age faces, one would expect us to be more sensitive to configural changes made to own-age faces compared to faces that belong to a younger or older age group.

#### **6.4. Experiment 8**

In order to assess whether the own-age bias is a result of an increased ability to successfully use the configural information in own-age faces, this study sought to directly manipulate this information, rather than inferring selective configural disruption from inversion. To do this, configural changes were made to a set of photographs of faces by altering the spatial arrangements between the facial features (e.g. moving the eyes up or down within the face). These changes ensured that while the configural information of the face was altered, the component information remained the same.

Previous studies which have investigated participants' configural sensitivity have blocked the stimuli according to the type of feature changes that were made to the face (e.g. Haig, 1984; Kemp et al, 1990). Participants were therefore aware of what

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<sup>12</sup> Perceptual expertise in this case being the product of relatively more experience, and therefore more familiarity, with own-age faces (with the added caveat that it may be recent exposure to own-age faces that is important in the own-age bias; see the introduction of this chapter for a discussion of this).

types of changes were likely to occur and as such it is possible that they were able to develop a strategy to detect these changes by focusing on those individual features alone. Indeed, Barton, Keenan & Bass (2001) found that participants were significantly better at detecting feature displacements when they knew which facial features were most likely to be altered. Therefore, in order to better test configural sensitivity, this study presented the changes in a randomised, non-blocked order, preventing participants from being able to work out which feature change was likely to occur.

In this study, undergraduates viewed own-age and other-age (child) faces. Children were not used as participants as the length of the task was thought to be too long to hold their attention. If the own-age bias is a result of perceptual expertise, it is hypothesised that participants will be more sensitive to the configural changes made to own-age faces. Specifically, participants should have a lower threshold at which they can identify the changes made to own-age compared to other-age faces.

#### *6.4.1. Design*

A repeated measures design was used, with two variables of interest: degree of spatial change (four levels: 1, 2, 4 and 8% of the inter-pupillary distance) and the feature changed (three levels: eye separation; vertical eye position; vertical nose position). Correct responses and reaction time data were used as dependent variables.

#### *6.4.2. Participants*

Initially 30 participants took part in this study; however two of them had to be excluded as their overall performance was at chance levels and their reaction times were too fast, suggesting they were not paying due attention. Of the 28 remaining participants there were 11 males (mean age 22.64, SD 2.77, range 19-28 years) and 17



females (mean age 21.76, SD 2.73, range 18-30 years) who were locally recruited undergraduate students from the University of Sussex.

#### 6.4.3. *Materials*

Digital photographs of 48 males were collected and used as the basis for stimuli. The photographs were equally divided into two age categories: children (9-12 years old) and undergraduates (19-25 years old). All photographs were close up, frontal face images without beards, glasses or other paraphernalia. For each photograph, four configurally changed images were created. There were six possible configural changes: eyes moved up or down, eye separation increased or decreased, or nose position moved up or down. For the purpose of analysis, these were treated as only three types of feature change: eye separation, vertical eye position and vertical nose position<sup>13</sup>. The magnitude of these changes were made in terms of a percentage of each face's inter-pupillary distance (IDP); either 1, 2, 4 or 8% (see Figure 6.9. for examples of the stimuli used). As such, there were 24 possible changes available to each face. Each of the changes were used equally (4 times each), but they were randomly assigned to the facial stimuli. Once the changes had been made, all photographs were then converted to greyscale and edited to a standard size of 350 x 300 pixels. The background of each picture and any information outside of the head outline and the contour of the chin was removed and made solid white.

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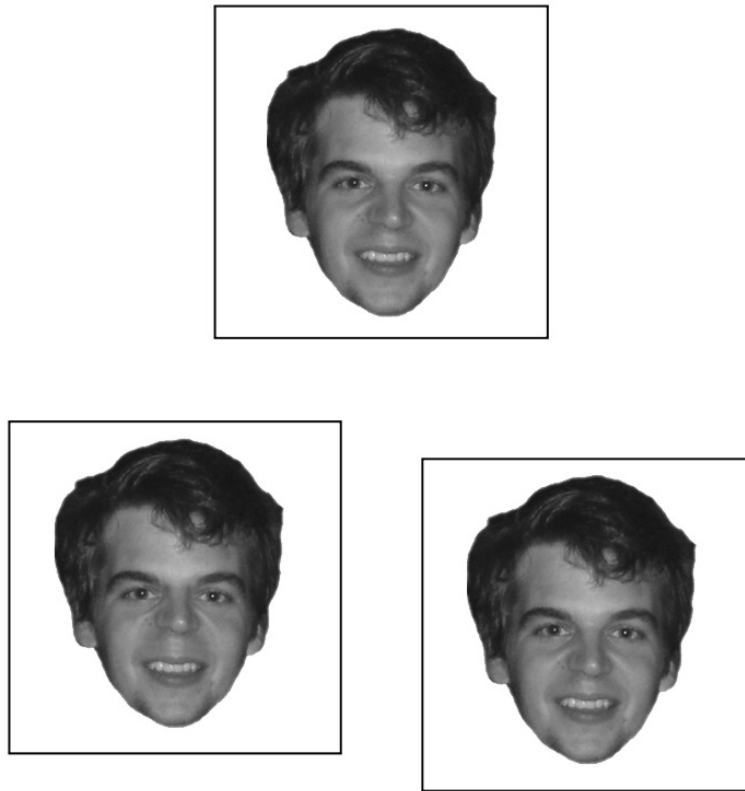
<sup>13</sup> Initial analysis showed that sensitivity to changes were the same along these dimensions, regardless of which direction they were in, thus the six feature changes were collapsed into three for ease of analysis and interpretation



**Figure 6.9** An example of the possible changes made to the photographic stimuli. From left to right: the original photograph, eyes moved up by 4% of the IPD, nose up by 8% of the IPD, eye separation increased by 2% of the IPD and nose moved down by 8% of the IPD.

#### 6.4.4. Procedure

In order to see if we are more sensitive to configural changes made to own-age faces than to other-age faces, a face matching task was used. For each trial triplets of faces were presented to the participants on a computer screen. The triplets consisted of the original facial photograph, which appeared at the top of the screen, with two versions of that photograph appearing directly beneath it. These two faces were slightly misaligned to hinder horizontal scanning. Of the two lower pictures, one was identical to the original, while the other had been changed using one of the 24 possible configural alterations (see Figure 6.10 for example stimuli). Which configural change the photograph was subjected to was randomly assigned. Participants were asked to identify which of the two faces had been changed, as accurately and as quickly as possible using the computer keyboard. There were 192 trials in totals, and these trials were split into four blocks of 48 with equal amounts of each age group in each block. The order of the blocks and faces within each block were randomised and the position of the target face was counterbalanced to avoid any response bias.



**Figure 6.10** An example of a triad of faces. The target face in this set of stimuli is positioned in the bottom left and has had the nose moved up by 8%. The final stimulus size was 910 by 910 pixels (32.1cm high) with a viewing distance of 45cm making the visual angle 39.26°.

#### 6.4.5. Results

There was no effect of position of target face, or gender on either accuracy or reaction time, so data were therefore collapsed across these variables for the purpose of analysis.

##### 6.4.5.1. Accuracy

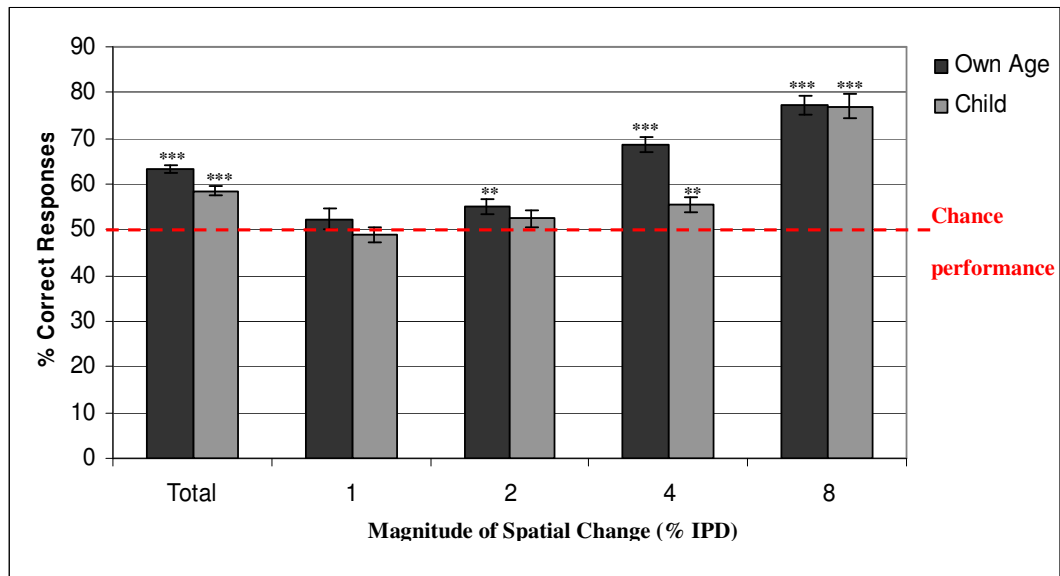
A three-way repeated measures ANOVA (two levels of face age x three levels of feature change x four levels of pixel change) was carried out on the percentage of correct responses that were made. Firstly, a significant main effect of face age was

found ( $F(1,27)=13.85, p=.001, \eta_p^2=.34$ ) with significantly more correct responses being made to own age faces (63.28%) than to children's faces (58.48%). There was also a significant main effect of feature type ( $F(2,54)=12.89, p<.001, \eta_p^2=.34$ ), which Bonferroni post-hoc tests revealed to be the result of significantly more correct responses occurring for changes in eye separation (66.52%) compared to vertical changes in the positioning of either the eyes (57.42%) or the nose (58.71%). In addition to this there was a further significant main effect of spatial change level<sup>14</sup> ( $F(2.13, 57.60)=53.62, p<.001, \eta_p^2=.67$ ). Bonferroni post hoc tests revealed that this was the result of accuracy increasing as the magnitude of spatial change increased. All differences were significant ( $p<.001$ ) except for the difference between 1 and 2 % of the IPD changes ( $p=.74$ ), which were close to chance.

While there was no interaction between face age and feature change ( $F(2, 54)=2.60, p<.13, \eta_p^2=.07$ ), there was a significant interaction between face age and spatial change level ( $F(2.19, 59.05)=4.94, p<.01, \eta_p^2=.16$ ) which is illustrated in Figure 6.11. In addition to this, there was a significant interaction between feature type and spatial change ( $F(6, 162)=2.41, p<.05, \eta_p^2=.08$ ), however the three-way interaction did not reach significance ( $F(6, 162)=1.88, p=.09, \eta_p^2=.07$ ).

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<sup>14</sup> Mauchley's test indicated that the assumption of sphericity had been violated for pixel change level ( $\chi^2(5)=14.43, p<.05$ ) and for the interaction between this variable and face age ( $\chi^2(5)=15.74, p<.01$ ). As a result, reported degrees of freedom are corrected using Greenhouse-Geisser estimates.

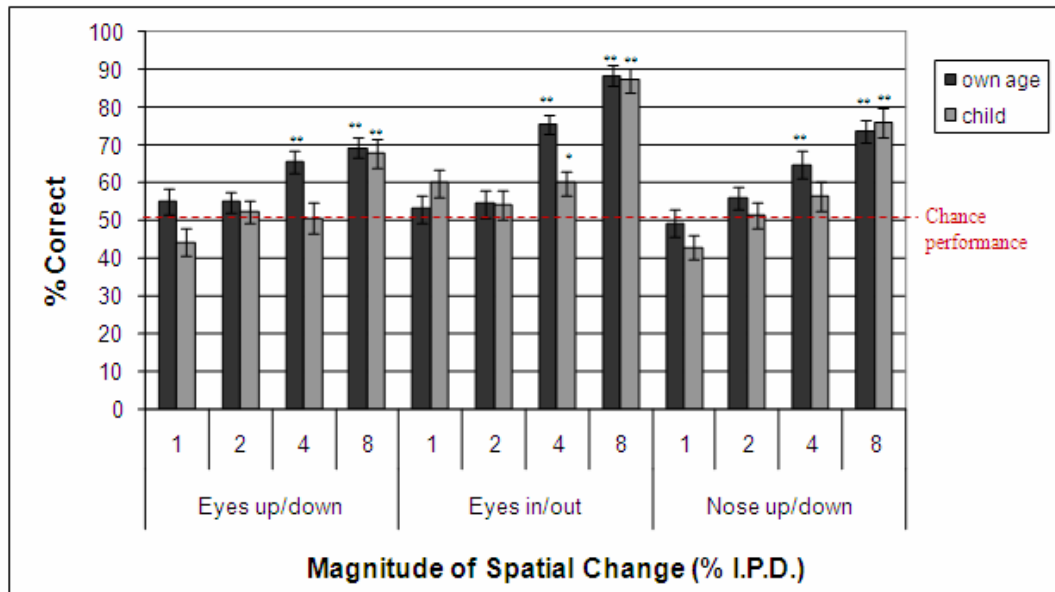


**Figure 6.11** The effect of face age and magnitude of configural changes made (in % IPD) on the mean percentage of correct responses made (error bars show mean  $\pm$  1 standard error). Asterisks indicate whether or not performance was significantly different from chance performance using one-sample t-tests (\*\* =  $p < .01$ ; \*\*\* =  $p < .001$ ).

In order to further investigate the interaction between face age and spatial change level, a series of follow-up paired samples t-tests were carried out, with face age as the variable of interest for each level of configural change. Only one significant result was found at the 4% level ( $t(27)=6.18, p < .001$ ), showing that significantly more correct responses were made for the own age faces (68.60%) than the children's faces (55.51%) when changes of the magnitude of 4% of the IPD were made to the target faces. Responses were similar in all other cases (largest  $t=1.05$ ). These findings suggest that the threshold to detect configural changes in own age faces may be lower than that for other age faces, consistent with a perceptual expertise account of the own-age bias.

This idea is further supported by a series of one-sample t-tests, illustrated in Figure 6.12., that were used to investigate whether performance for the different stimulus conditions was significantly different from chance. For the own age faces,

performance was only at chance performance when the magnitude of configural change was 1% ( $t(27)=1.01, p=.32$ ), however for children's faces performance was at chance level for both 1 and 2% changes ( $t(27)=-.59, p=.56$ ;  $t(27)=1.40, p=.17$  respectively). Thus, undergraduates were able to detect configural changes made to the face at a level significantly better than chance for alterations made at a barely noticeable magnitude of 2% of the IPD. This was not true for children's faces until alterations were of the magnitude of 4% of the IPD.



**Figure 6.12** The effect of feature type and magnitude of configural changes made (in % IPD) on the mean percentage of correct responses made (error bars show mean  $\pm$  1 standard error). Asterisks indicate whether or not performance was significantly different from chance performance using one-sample t-tests with Bonferroni correction (\*\* =  $p < .001$ ; \* =  $p < .01$ ).

In order to further investigate the feature type x spatial change level interaction a series of follow up one way ANOVAs were carried out with face age as the variable of interest for each level of configural change. The only significant result was found at the 8 % change level ( $F(2, 54)=18.14, p<.001, \eta_p^2=.40$ ), which Bonferroni post hoc tests showed was the result of eye separation changes producing significantly more correct

responses than either the eyes or nose being moved vertically within the face ( $p < .001$  in both cases).

#### 6.4.5.2. *Latency*

As with the accuracy data a three-way repeated measures ANOVA was carried out on the reaction time data for correct responses. In this case, no significant main effect of face age was found ( $F < 1$ ). However there was also a significant main effect of feature type ( $F(2,54) = 12.89$ ,  $p < .001$ ,  $\eta_p^2 = .34$ ), which Bonferroni post-hoc tests revealed to be the result of significantly faster reaction times occurring for changes in eye separation (mean = 3425.74, 2778.56) compared to vertical changes in the positioning of either the eyes (4027.44, 2931.75) or the nose (3993.70, 3410.59). In addition, there was a further significant main effect of spatial change level<sup>15</sup> ( $F(1.90, 49.39) = 7.97$ ,  $p = .001$ ,  $\eta_p^2 = .24$ ). Bonferroni post hoc tests revealed that this was the result of reaction times for faces with configural changes of a magnitude of 8 % of the IPD being significantly faster than at all of the other change levels ( $p < .01$  in all cases). No other differences in response speed were found and there were no significant interactions between any of the variables (largest  $F = 1.81$ ). These findings suggest that the differences in accuracy cannot be explained in terms of a speed-accuracy trade off.

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<sup>15</sup> Again, Mauchley's test indicated that the assumption of sphericity had been violated for pixel change level ( $\chi^2(5) = 14.43$ ,  $p < .05$ ) and so reported degrees of freedom are corrected using Greenhouse-Geisser estimates.

#### 6.4.6. *Discussion*

Experiment 8 sought to investigate whether a configural-expertise account of the own-age bias was plausible, by using a paradigm that specifically manipulated the configural information in the face while preserving the featural information. The results found that, in terms of accuracy, undergraduates were significantly more accurate than chance at detecting changes made to own-age faces at a lower level than that for other-age faces (2%, compared to 4% of the IPD). In addition, at a level close to that identified by Haig (1984) as where configural alterations become just noticeable (4% of the IPD), participants were significantly more accurate at detecting changes made to own- compared to other- age faces. Thus participants appeared to have a lower threshold at which they were able to detect configural changes made to own-age faces and were more accurate at detecting the subtle changes made to them.

### 6.5. **General Discussion**

This chapter aimed to investigate whether a perceptual expertise explanation, characterised by increased configural processing for own-age faces, offers an appropriate account of the own-age bias in face recognition. Using an inversion paradigm similar to that used to investigate the role of expertise in the own-race bias (e.g. Rhodes et al, 1989; Sangrigoli & de Schonen, 2004) Experiments 6 and 7 found that this might be the case. Low-contact adults showed better recognition accuracy (in Experiment 6) and faster response times (in both Experiment 6 and 7) for own-age faces when they were presented upright; a pattern that was eliminated when the faces were



inverted. Children showed the same pattern in terms of accuracy for children's faces in Experiment 6. In contrast, the high contact group exhibited no such pattern.

The fact that inverting the facial stimuli eliminated the pattern of enhanced recognition for faces with which participants had high levels of experience, in most cases eliminating the face age  $\times$  group interactions completely, supports the notion that the own-age bias is mediated by perceptual expertise. This finding is in direct opposition to that reported by Perfect and Moon (2005), who found that inverting their faces increased the own-age bias. Instead, these results favour the findings of Kuefner et al (2008), who found a similar pattern of results to those seen in this chapter. Thus, it appears that a perceptual expertise account of the own-age bias may offer a satisfactory explanation of this effect.

However, inversion studies alone are not enough to allow us to conclude that own-age faces are processed in a more configural manner than other-age faces. As discussed above, previous research has indicated that inverting a face not only disrupts the configural information in that face, but also the featural information, although to a lesser degree (Mondloch, Le Grand & Maurer, 2002). Thus, to be able to make claims about the role of configural processing in the own-age bias, one needs to look at manipulations that tap into those processes alone.

In order to do this, Experiment 8 investigated undergraduate's sensitivity to small configural changes made to the face. It was found that participants had a lower threshold for detecting these subtle changes when faces belonged to their own age group, compared to those belonging to a different age group. In addition, participants performed more accurately with own-age compared to other-age faces when the changes made were at the just noticeable level (4% of the IPD; Haig, 1984). This

finding suggests that participants were better able to use the configural information contained in own-age faces compared to other-age faces, directly supporting the configural-expertise account of the own-age bias.

However, it is worth noting that only one participant group was included in this study. As such it is possible that these results are the product of configural changes being generally harder to detect in children's faces than in adults' faces. This does seem unlikely, due to the physiognomic difference between adult and children's faces. For example, as discussed in Section 1.5.1., children's eyes appear relatively larger within a child's face, compared to an adult's face. As such, slight movements to their eyes (as a proportion of their I.P.D.) would most likely represent a relatively larger change within the face as compared to that made for the adult. However, in order to rule out the possibility that the findings of Experiment 8 were a product of the stimuli used, future research could investigate whether participants with high contact to children (such as teachers) show this increased sensitivity to configural changes made to own-age faces. If the own-age bias is the product of perceptual expertise, we would not expect this to be the case.

However, the notion of greater configural processing for own-age faces has also gained support from a recent study which used a composite face paradigm (de Heering et al, 2008). Using high- (teachers) and low- (undergraduates) contact participants, the authors investigated the composite face effect for adult and child faces. While the low contact participants showed a much larger composite effect for adult compared to children's faces, no difference was found for the high contact group. This finding suggested that due to enhanced configural processing for faces with which we have more experience, the low contact group was relatively unable to successfully use the

featural information in own-age faces to successfully identify the face halves. The high contact group experienced the same problem for both face ages, as they had high levels of expertise with both age groups. In contrast, as the low contact group had less experience with children's faces, they were more able to use the featural cues in the face.

Thus, the results from the experiments in Chapter 6 support a perceptual-expertise explanation of the own-age bias in face recognition, characterised by enhanced configural processing for own-age faces. However, these studies are only investigating the perceptual mechanisms underlying the own-age bias. They do not take into consideration more social or motivational models, and permit no conclusions about the role of these more qualitative aspects of experience with faces. These different types of explanations are by no means mutually exclusive, and while this chapter leads us to conclude that own-age bias is likely to be the result of enhanced perceptual processing for own-age faces, it is possible/likely that social and motivational mechanisms and behaviours are what lead us to develop this perceptual expertise. This idea merits further exploration and will be discussed in the final chapter of this thesis.

## **Chapter 7 :**

### **General Discussion**

#### **7.1 Overview**

Previous research has suggested that we are better at recognising faces belonging to our own age-group compared to those of another age group (e.g. Anastasi & Rhodes, 2006). This own-group recognition advantage is potentially analogous to that seen for other facial characteristics: the own race-bias (see Meissner & Brigham, 2001) and the own-gender bias (e.g. Shapiro & Penrod, 1986). As such, the overarching aim of this thesis was to use research into these biases to try and establish the possible mechanisms that might be responsible for producing the own-age bias in face recognition.

Perhaps the most well-known explanation of any of the own-group biases is that of the contact hypothesis (e.g. Brigham & Malpass, 1985; in terms of the own-race bias). Building on this idea, the first half of this thesis sought to investigate the role that contact may play in the own-age bias in face recognition. However, as this type of theory is only a high level theory, it does not make any specific predictions about the mechanisms that may underlie this type of bias in face recognition; only that increased contact with a group of faces will lead to better recognition of those faces as a result of more familiarity with them. As such, the second half of this thesis aimed to explore the possible cognitive, social and motivational mechanisms that may be responsible for producing the own-age bias in face recognition.

This chapter will provide an overview of the findings of the empirical studies carried out in this thesis and couch them in terms of the existing literature in the area. As a result, this chapter will also aim to establish what the most feasible explanation(s) of the own-age bias is likely to be. Finally, limitations of this thesis and directions for future research will be identified and discussed.

## **7.2 An Own-Age Bias in Face Recognition?**

As has been discussed throughout this thesis, previous research has suggested that we are better at recognising faces belonging to our own age-group compared to those of another age group (e.g. Anastasi & Rhodes, 2006). However, not all work in this area has produced consistent results. For example, of the studies that have investigated the own-age bias in different adult age-groups (for adult faces), some have found an own-age bias to be present in younger, but not older adults (e.g. Bartlett & Leslie, 1986; Fulton and Bartlett, 1991; Mason, 1986; Wiese et al, 2008), while others have found the reverse to be true (e.g. Anastasi & Rhodes, 2006; Exp 2). In addition, some have found a full cross-over effect, with an own-age recognition advantage for all adult groups (e.g. Anastasi & Rhodes, 2006; Exp1; Perfect & Moon, 2005), while others have found no evidence of a bias at all (e.g. Memon, Bartlett, Rose & Grey, 2003). As such, the current literature on the own-age bias in face recognition has produced extremely mixed results.

Research investigating the ability of children and adults to recognise child and adult faces, although a lot less studied, has proved similarly problematic. Chung (1997) found evidence for an own-age bias in young adult participants (as did Kuefner et al,

2008), but not children, while Crookes and McKone (2009) found the opposite pattern. In contrast, Anastasi and Rhodes (2005) found that children and older adults both exhibited an own-age bias. Thus, again, it is unclear whether an own-age face recognition advantage exists in these cohorts.

One of the possible reasons why such varied findings may have been produced could be explained by the presence of one simple, yet significant error in the literature. The majority of studies that have investigated the own-age bias in face recognition have largely failed to suitably match the age of their participants to the ages of the “own-age” stimuli that they used (see Table 2.1. for a summary of these studies). As such, it is questionable whether these studies could really be described as investigating an own-age bias at all.

Of the above-mentioned studies, only 4 managed to successfully age-match their facial stimuli to their participants: Anastasi and Rhodes (2005; 2006 Exp 1), Kuefner et al (2008) and Perfect and Moon (2005). Each of these studies found that all examined age groups were better at recognising own-age faces compared to other-age faces. However, while it is probably safe to conclude that the adults included in these studies exhibited an own-age bias, this is less certain for the child populations. Even though Anastasi and Rhodes (2005) successfully matched the ages of their stimuli to their participants, their procedure presented a problem. Asking participants to categorise faces at the encoding phase according to which age band the faces belonged to may have drawn participants’ attention to age as a particularly salient facial cue, which may not ordinarily have occurred. As categorising faces into own- and other- groups has been shown to encourage own-group biases in face recognition (e.g. Bernstein et al, 2007) it could be that the resultant own-age bias was a product of this task, rather than a

natural phenomenon. As such, Experiment 1 aimed to establish whether or not an own-age bias was present in children and young adults when they were presented with matched-age stimuli and not asked to categorise them beforehand.

The main finding from the first experiment in this thesis was that both children and young adults exhibited a significant own-age bias in terms of accuracy (as measured by  $d'$ ). Analysis of hit and false alarm rates indicated that this was driven by an increased propensity for both age groups to correctly identify own- compared to other-age faces. In contrast, false alarms showed no such effect (drawing parallels with the pattern of results found for the own-gender bias; Shapiro & Penrod, 1986). While young adults also showed an own-age bias in terms of RTs, the trend for children to recognise own-age faces faster than other-age faces did not reach significance. However, as discussed in Chapter 2, it is unclear how representative RTs were of the child groups' actual ability.

Thus an own-age bias has been found to exist in both child and young adult populations, supporting the idea that this phenomenon is seen when "other-age" faces comprise either younger or older faces (e.g. Anastasi & Rhodes, 2005; 2006 Exp 1; Kuefner et al, 2008; Perfect & Moon, 2005). This pattern of results serves as a useful starting point for investigating why this bias in face recognition may occur, particularly if one draws parallels with the most commonly cited explanation proffered for a similar, more commonly observed bias: the own-race bias. The fact that we are better at recognising faces of our own race in comparison to those of another race is most often explained in terms of the differential amount of contact that we have with different racial groups (e.g. Brigham & Malpass, 1985). As a result of spending more time with faces belonging to our own racial group, the theory is that we become more familiar

with these types of faces, and our memory and recognition abilities for these faces increases as a consequence. A similar theory could be put forward to explain the own-age bias. It is possible that the own-age bias is the product of increased experience (and more familiarity) with faces that are similar in age to ourselves. This is particularly likely to be the case in terms of the participants that were involved in Experiment 1 who were all recruited from settings where high own-age contact would be likely to occur on an almost daily basis: the children were recruited from a school, and the young adults from a university.

However, as appealing as the contact hypothesis may be, accepting such an explanation of the own-age bias is not as simple as it is for the own-race bias, namely due to the fact that unlike race, age is not a stable characteristic. As adults, we have previously belonged to other, younger age groups. Presumably this experience would allow us to gain enough familiarity with faces of younger age groups to allow high levels of recognition, to be achieved, similar to those for own-age faces. However, Experiment 1, and previous studies that have used successfully age-matched stimuli, have shown superior own-age face recognition to occur even when other-age faces belong to a younger age group than the participants. As such, for the contact hypothesis to apply we would need to include a caveat to this theory: that it is recent (socially salient) exposure that is most important in the mediation of the own-age bias.

### **7.3 The Contact Hypothesis and the Own-Age Bias**

Experiment 2 sought to directly investigate the role that inter-age group contact may play in the own-age bias in face recognition. As highlighted above, contact-type



explanations have been used to try and explain other biases and have had some degree of success in terms of the own-race bias (see Section 1.8.1.1. and Meissner and Brigham, 2001). However, support for this type of explanation for the own-gender bias is more mixed (see Clifford and Bull, 1978 for a discussion of this). Equally, a contact-type explanation could be put forward to explain the own-age bias in face recognition, with the caveat that it is recent exposure that may play an important role in this bias, rather than a more cumulative measure that is often seen in the own-race bias literature.

In order to test the influence of recent experience with different age groups on the own-age bias, Experiment 2 investigated the face recognition abilities of similarly aged participants who had either high (trainee teachers) or low (undergraduates) contact with other age faces (in this case, children). The results showed that while the low contact group exhibited the typical own-age bias in terms of both accuracy and RTs, the trainee teachers showed no such bias, instead performing better for child faces than with own-age faces (although this pattern only reached significance for the RT data). These findings give credence to the hypothesis that contact plays an important role in the own-age bias in face recognition. The lack of significant correlations between the self-reported measure of contact and the magnitude of trainee teachers' own-age bias suggest that cumulative measures of contact may not be appropriate in explaining this bias (although self-report measures are notoriously problematic, and thus the lack of significant findings may have been a function of the tools used). Thus it could be said that these results support the idea that recent contact with an age group is important in producing, or reducing, the own-age bias in face recognition.

The idea that recent exposure to (socially salient) own-age faces may be responsible for the production of the own-age bias is one that may also be able to

explain why previous research into this phenomenon has yielded such varied results (as discussed in the previous section). Chapter 3 highlights this as being a possibility when, in a review of the existing papers investigating the own-age bias, it was found that of the participant groups that exhibited a significant bias, almost 90% were recruited from settings where they were likely to have experienced particularly high levels of exposure to own-age faces (e.g. universities, retirement homes). In contrast, approximately 73% of the participant groups that showed no own-age bias were recruited from settings that were either unknown, or likely to have more varied levels of daily contact with own-age faces (e.g. from the local community, recruited through advertising). Thus a contact hypothesis emphasising the importance of recent contact with faces does appear to be a valid possibility for explaining the own-age bias in face recognition.

As well as providing support for a contact-type explanation of the own-age bias, Experiment 2 also shed some light on the mechanisms through which contact might exert its effects. However this will be discussed in more detail in the next section of the discussion. Before considering the underlying mechanisms that may be responsible for producing the own-age bias, further consideration should be given to the role that contact plays in this phenomenon, specifically with a view to identifying exactly what it is about contact that is important for such a bias to occur.

### 7.3.1 *Qualitative versus Quantitative Aspects of Contact*

As highlighted in Section 1.8.1.1. of this thesis, contact can be thought of in a number of ways. Using Experiment 2 to illustrate this, it is fair to say that the trainee teachers and undergraduates differed in terms of the *quantity* of contact they had with children. However, it is also likely that the two groups differed in terms of the *quality*

of contact they had with this age group, as trainee teachers are likely to have increased interest in, and thus more motivation to attend to them as a result of their occupational demands. Thus contact could be conceptualized in terms of both quantitative and qualitative measures, the question is, which is likely to be most important in explaining the own-group biases seen in this thesis and the wider face recognition literature?

In terms of this thesis, Experiment 2 found that the quantity of time that trainee teachers had spent with other-age faces was not significantly related to the size of their own-age bias. While this could be interpreted as evidence against the role of quantity of contact (alone) in the own-age bias, this may not be the case. It could have been due to ceiling effects with both groups of faces, thus not allowing for enough variability in the participants' scores to yield meaningful results. Alternatively, it may be that the assumption of a linear relationship between quantity of exposure and own-age bias is a faulty one. It is entirely plausible that there is a threshold, above which exposure no longer exerts any effects.

An additional reason for this finding may be due to the reliability (or lack thereof) of the contact measure used. Self-report measures are notoriously problematic as they are easily distorted by inaccuracies of memory and response biases. However it is also possible that the results may be due to the fact that the concept of contact is such a complicated one, with many different facets, that asking only one question about the amount of experience participants had with children may have been insufficient to gauge contact. Thus, the types of problems encountered by studies using self-report measures are various and plenty. As such, this thesis sought to investigate the relative importance of the qualitative and quantitative aspects of contact on the own-age bias using less problematic study designs.

Due to the plethora of problems associated with assessing contact through self-report measures (see Section 4.1.1. for a more in-depth discussion of this), Experiments 3 and 4 aimed to establish the important aspects of contact in mediating the own-age bias by attempting to tease apart the three components of exposure identified by Slone et al (2000): frequency, variability (both quantitative factors) and quality. Experiment 3 sought to tease apart the two aspects of quantity of exposure. Using primary and secondary school teachers as participants, this study hypothesized that while primary school teachers are likely to have more frequent contact with their students than secondary school teachers, they see a smaller number of students; the variability of exposure is higher in the secondary school teachers. Thus, finding a recognition difference between these two groups should shed some light on which of these two quantitative contact measures is more important in the own-age bias.

Both teaching groups performed similarly for own-age and children's faces, suggesting a similar influence of the two quantitative measures of contact, although only primary school teachers differed from the controls in terms of accuracy scores. In addition, the effect sizes for the non-existent own-age biases revealed that the own-age bias was eliminated to a greater extent in the primary school teachers; so much so that this cohort actually performed better with children's faces. While there are obvious limitations to how far non-significant findings can be taken in terms of meaningful interpretation, this pattern does suggest that further research might benefit from exploring the idea that frequency of other-age exposure may be more influential than variability of that exposure.

However, as discussed in Chapter 4, it is possible that primary and secondary school teachers have a different quality of contact with their students due to differential

occupational demands (and thus any differences in their performance could be due to this factor). Experiment 4 therefore sought to investigate the role of quantitative exposure and more qualitative aspects of this contact in the own-age bias. As previous training studies with the own-race bias have implicated the importance of motivation and attention in reducing the own-race bias (e.g. Hills & Lewis, 2006; Malpass et al, 1973), and as Experiment 2 highlighted the possibility that motivational factors play a important role in the own-age bias, motivational aspects of quality of contact were specifically manipulated by using monetary rewards for correct responses. Visual experience with other-age faces was also investigated, as was a combination of these factors.

The main finding of Experiment 4 was that while exposure alone was not enough to significantly reduce the size of the own-age bias in face recognition, this bias disappeared for both the motivation condition (only when measured in terms of accuracy) and the combined "motivation and exposure" condition. Thus, these results suggest that recent quantitative exposure alone is not enough to reduce the own-age bias in face recognition, however qualitative motivational/attentional aspects may be. Looking at the effect sizes (and considering the fact that the motivation condition only produced an elimination of the own-age bias in terms of accuracy, and not RTs), these findings suggest that it is a combination of both qualitative and quantitative aspects of contact that are most important in mediating the own-age bias.

This hypothesis is mirrored in the own-race bias literature. Hills and Lewis (2006) highlighted the importance of a combination of quantity of exposure and differential attentional strategies used for own- and other-race faces in the mediation of the own-race bias. They found that simple exposure to other-race faces was not enough

to reduce the own-race bias. However, when participants were additionally encouraged to attend to specific facial features that were particularly important for differentiating faces of that race (e.g. Ellis et al, 1975), this bias disappeared.

Thus, the findings of Experiment 4 and Hills and Lewis (2006) suggest that recent exposure alone may not be sufficient to significantly reduce these own-group biases, instead highlighting the importance of motivational and attentional factors in these effects. The similarity in these findings offer some support for the notion that these phenomena may be similar in terms of their genesis (at least to some degree). However, one aspect of Experiment 4 is at odds with a recent study from the social-categorisation literature which found no influence of general motivation (without exposure) on the magnitude of the own-race bias in terms of accuracy. Instead, Hugenberg et al (2007) found that informing participants of the own-race bias in face recognition and instructing them to attend specifically to individuating information for other races faces was sufficient to eliminate the cross-race effect. The authors claimed that it is not motivation to remember faces that is important, *per se*; instead it is the attention paid to the most relevant features for the goal of individuation. As these other-race features are most likely the same as those participants were encouraged to attend to in the Hills and Lewis study, this may well be the most viable interpretation of these findings.

Indeed, the hypothesis that the own-race bias is the product of differential attention paid to the most appropriate features for group-member individuation may also be relevant to explaining the own-age bias. While Experiment 4 concluded that it is the combination of exposure and motivation that is most effective in eliminating this bias, there is an alternative interpretation of these findings. The instructions given to the

participants in this group specifically encouraged them to identify the way in which sets of faces within each age band differed from one another and then use this information to best remember faces in the recognition test. Thus participants were encouraged to attend to individuating information more in this condition than any other. As such, it is possible that the elimination of the own-age bias in this condition was the result of specifically eliciting an individuation strategy for out-group members, rather than increasing their motivation to attend to the faces *per se*. However the elimination of the own-age bias in the motivation only condition in terms of accuracy scores suggests that motivational factors are likely to be involved, at least to some extent.

Thus, from these results it is difficult to establish whether a motivation or individuation explanation of the findings is most appropriate (although if the own-race bias and own-age bias are truly analogous, one would assume it is the latter). As such, it is necessary to consider these findings in terms of the possible mechanisms that may be responsible for producing such an effect. While motivation may be an explanation for this effect in itself, individuation is suggestive of a more specific social-cognitive theory: a social categorisation theory. If one can distinguish which of these hypotheses best fits the pattern of behaviours seen in terms of the own-age bias, then one might be able to tease these two explanations apart.

#### **7.4 Possible Mechanisms Underlying the Own-Age Bias**

The over-arching aim of this thesis was to investigate the possible explanations of the own-age bias using accounts offered for other biases in face recognition as a useful starting point. As established in the previous section, the account most

commonly put forward to explain the most frequently cited of these biases (the own race bias) is that of the contact hypothesis. As Chapter 2 has highlighted (as well as other work by Kuefner et al, 2008) exposure to other-age faces mediates the own-age bias in face recognition. In addition, in line with previously discussed work on the own-race bias, it seems that quality, rather than quantity of exposure (although most likely a combination of the two) is what is important in the mediation of its effects (see Chapter 3 and 4). However, exactly how contact exerts its effects remains unclear. Thus, in order to establish what underlying cognitive, social and/or motivational-attentional mechanisms are likely to be responsible for the production of the own-age bias, it is worth revisiting the theories put forward to explain other biases in face recognition, outlined in Chapter 1.

#### *7.4.1 A Motivational-Attentional Model*

The first explanation of the own-age bias that is tackled experimentally in this thesis is that of a motivational/attentional account and it is possibly the simplest of the theories proffered to explain this phenomenon. This type of explanation suggests that contact does not affect face processing per se, rather it is a reflection (or driver) of the degree of interest one has with one group of faces over another and the differential amount of attention subsequently allocated to them. For example, Rodin (1987) suggested that we are “attentional misers” when it comes to processing visual information. As such, we only assign attentional and cognitive resources to individuals who we perceive as important to us in some way. In contrast, those who we are not driven to attend to are often cognitively disregarded, allowing us to direct our cognitive resources elsewhere. The interesting thing about this type of theory is that it does not



specify exactly what features might serve as "disregard" cues. They are not thought to be fundamental stable cues, instead they are thought to be goal-specific and as such vary from situation to situation. Rodin herself states that disregard is likely to occur to people who are "deemed unsuitable for our social purposes" and thus are dependent on social rewards and punishments associated with paying attention to one group of individuals over another.

In terms of the own-race bias, we have seen in Section 9.3. that attentional aspects are indeed likely to play a role in producing this bias. Along a similar vein, an analogous motivational-attentional account could be put forward to explain the own-age bias. Indeed, Rodin (1987) suggested that age would be a likely factor to serve as a disregard cue. For example, she suggested that old age is likely to be such a cue in those who are not old themselves, as the elderly are unlikely to make suitable candidates for most types of social interactions and relations. In terms of the own-age bias witnessed in Chapter 2 of this thesis, a similar type of explanation can be put forward. It is unlikely that children would meet the criteria for the social purposes of an undergraduate (and vice versa), and as such this type of theory would predict a full-cross over effect, as was observed.

In addition, a motivational-attentional account, which emphasises the plasticity of disregard cues and the importance of situation-specific goals, could also happily account for the pattern of results witnessed in Chapter 3. The occupational demands of teachers would likely dictate that children's faces should be allocated a significant amount of attention (something that is unlikely to be the case for undergraduates). In addition, the normal social rewards and punishments associated with the correct recognition of socially salient own-age faces is likely to be similar for both groups of

similarly aged participants. As such, this theory would predict the two groups to perform similarly for own-age faces, but differ for children's faces. Specifically, the undergraduates would be expected to exhibit an own-age bias, while the teachers would not. As seen in Experiments 2 and 3, this was indeed the case.

So a motivational-attentional account of the own-age bias in face recognition appears to fare relatively well in terms of the pattern of results found within this thesis. And, in Experiment 4, where motivational and exposure components of contact were pitted against each other, some support for this hypothesis was also garnered. As discussed in the previous section, this study found that while exposure alone was not able to reduce the own-age bias, motivational aspects were able to achieve this (although this was not the case for the RT data). However, the condition most successful at eliminating this bias was that which combined both motivational and experiential aspects of contact. However, significant group by face age interactions were not found for either accuracy or reaction time data, so one needs to be careful not to overstate these findings.

In summary, it appears from Experiments 1-4 that a motivational account may be able to explain the own-age bias in face recognition. However, the pattern of findings from Experiment 4 suggests that quantitative exposure factors may also be at play, when combined with the qualitative motivational drivers. However, this is not the only interpretation of these results. As suggested in the previous section, due to the nature of the instructions given in the combined motivation and exposure condition of this study, this pattern could also be accounted for by a social-categorisation model. The role of both this type of account and a more experience-based theory will be evaluated in the following sections of this discussion.

#### 7.4.2 *Social-Categorisation Model*

As explained in Chapter 5, one class of theory that has been put forward to account for the own-age bias in face recognition is that of the social-categorisation model (e.g. Levin, 1996; 2000; Sporer, 2001). This type of theory states that own-group biases (i.e. the own -race, -gender and -age biases) in face recognition occur as the result of our propensity to group people into categories according to whether or not they belong to our social in-group (e.g. Tajfel et al, 1971). Specifically, in the social psychology literature Fiske (1993) suggested that people naturally tend to rely on fundamental cues such as race, age and sex when categorising others. It is the social grouping which is thought to drive the way we subsequently process an encountered face. At the core of this type of theory is the assumption that out-group members are thought of at a categorical level, at the expense of more individuating information, while in-group members are individuated (e.g. Bodenhausen et al, 2003).

A specific model that has been put forward to explain the better recognition of out-group faces in terms of the own-race bias, is that of Levin's (1996; 2000) race-feature hypothesis. Levin suggests that the social tendency that people have to think categorically about out-group members leads individuals to search for category-specifying features (e.g. skin colour in the case of race) in other-race faces, to the detriment of more individuating information. In contrast, as in-group members are thought of at the exemplar level, they are processed accordingly (see MacLin & Malpass, 2001; 2003). Thus according to a social-categorisation model, these biases are not due to differential experience with faces, rather they are the result of differences in the social cognitions typically elicited when processing in-group and out-group faces.

As such, the role of contact in these biases is not one that affects face processing *per se*, instead it is more likely to reflect (or govern) in-group and out-group relationships.

Levin's race-feature hypothesis (1996; 2000) was put forward to explain the co-existence of two seemingly paradoxical phenomena: the own-race bias and the other-race classification advantage (see Chapter 5 for further discussion of this). And while this theory is specific to the own-race bias, a similar type of hypothesis (i.e. one that is dependent on the existence of an out-group specifying feature) could easily be used to account for the own-age bias (relying instead on age specifying information, such as skin texture). In fact, one theory that has specifically built on Levin's work to incorporate other biases is that of Sporer's (2001) In-group/Out-group Model (IoM). Similarly to Levin, this model suggests that upon viewing an out-group face, it is automatically categorised as belonging to an "out-group". However, Sporer integrated more detailed cognitive elements into his theory, specifically hypothesising that while in-group faces are encoded in an automatic, configural manner (typical of expert face processing), the categorisation of out-group faces results in a reduced, less efficient processing strategy for those faces (e.g. more feature-based processing) and as a direct result, recognition of those faces suffers. One of the interesting things about the IoM in terms of this thesis is that Sporer explicitly claims that it can be extended to explain other own-group biases in the face recognition literature, specifically the own-age bias (e.g. Wright & Stroud, 2002).

Support for the idea that in-group faces are better remembered as a result of more individuating information being processed for them, compared to out-group faces, has come from a recent study by Hugenberg et al (2007). As mentioned in Section 9.3., this study showed that merely altering the instructions that were given to participants

before an old/new face recognition task was enough to alter the size of the their own-race bias. Specifically, encouraging participants to think about individuating information of other race faces was enough to eliminate the own-race bias completely. In contrast, giving participants instructions that just encouraged them to attend closely to the faces (their so-called general accuracy motivation condition) did not affect the cross-race effect. The authors concluded that while general motivation alone could not explain the own-race bias, a theory suggesting differential use of individuating features may be appropriate.

However, it is worth considering how much motivation simple instructions are really likely to elicit in participants in Hugenberg et al's (2007) study in comparison to the social motivations that are likely to exist in the real world. Instead, it may have been better to offer the participants some kind of reward (or punishment, like that seen in some training studies; Malpass et al, 1973) for correct/incorrect responses. For example, Experiment 4 in this thesis showed that when monetary awards were given in reward for correct responses, motivation to perform well was enough to reduce the in-group bias seen in terms of age group (at least in terms of accuracy). However, the condition that proved most successful at eliminating the own-age bias was that which combined both motivation and exposure aspects of contact. The instructions given to participants in this condition specifically drew their attention to individuating information in a similar way to Hugenberg and colleague's own-race bias study. As such, this latter finding could be interpreted as being consistent with Sporer's (2001) IoM, although the finding that motivation alone appeared to diminish the magnitude of the participants' own-age bias is problematic for this model.

Theoretically, a social-categorisation type model could easily be applied to the own-age bias in face recognition, especially given the fact that age has been identified as one of the fundamental criteria according to which we automatically categorise people (Fiske, 1993). This type of explanation has also been shown to be flexible enough to account for in-group biases outside of the own-race bias literature. For example, Bernstein et al (2007) demonstrated categorisation effects for artificially assigned grouping categories, in addition to those that naturally occur. Specifically, they found that randomly labelling faces according to university affiliation or a personality type that was either congruent or incongruent to that of the participants, significantly affected the participants' recognition of those faces. Those perceived as belonging to the participants' in-group were better remembered than those who were not. This study provided evidence that merely labelling a face as being an in-group member is enough to elicit an in-group bias.

If a social categorisation account can satisfactorily explain the own-age bias in face recognition, then the labelling of faces as in-group members (i.e. belonging to the same age group as themselves) should result in better recognition for faces assigned to that in-group compared to those labelled as out-group members. In addition, reducing the social salience of one social category (i.e. age) while increasing that of another (i.e. gender) should be enough to reduce an own-age bias, and facilitate an own-gender bias in face recognition. Experiment 5 investigated these specific predictions and found that they were not supported. Participants performed more accurately for own-age faces regardless of whether they initially classified faces according to age or gender (although improved performance for own-age faces did not reach significance in terms of RTs for the gender classification group). Most problematic for a social-categorisation

explanation is the fact that there was no evidence of an own-gender bias in participants who initially categorised faces according to gender. However it is possible that this is a result of gender being a less salient social categorisation cue than age. If this is the case, then it could be that age was being implicitly categorised as the most salient in-group/out-group dimension, even when the explicit categorisation task demanded categorisation according to gender.

This notion has gained some support in an ERP study investigating the implicit and explicit processing of age and gender cues (Weise et al, 2008). In this study the authors found that even when age classification was incongruent to the task, participants still processed this cue. In contrast, gender was only processed when the task specifically demanded it. Thus it is possible that the social-categorisation process was responsible for the observed pattern of results in Experiment 5, with age information serving as the categorisation dimension. However, previous research that has demonstrated mere in-group/out-group labelling effects according to bogus, and therefore relatively unimportant, social dimensions (e.g. Bernstein et al, 2007) make this justification of the findings a little less plausible.

An additional problem for a social-categorisation hypothesis was the finding that the own-group advantage for classifying own-age faces was not significantly related to the size of the own-age bias exhibited, as an out-group feature processing account would hypothesise (e.g. Levin, 1996; 2000). However Sporer's IoM, which does not necessarily rely on feature categorisation, may still be able to account for the own-age bias in face recognition.

However, this thesis has produced two patterns of results that the IoM struggles to explain. Firstly, Sporer's model (illustrated in Figure 5.1) specifically predicts that in

addition to a recognition advantage for in-group faces, one should also see a more conservative response criterion for those faces (as often seen in the own-race bias literature, see Meissner & Brigham, 2001). Consistently throughout this thesis no such effect has been found. In addition, the finding that teachers recognise children's faces as accurately as own-age faces (Experiments 2 and 3) also presents a problem for this type of model. If in-group faces are classified according to socially important self-referential information (Fiske, 1993; List, 1986) then it is highly unlikely that children would be classified by young adults in the way. Thus, the results in this thesis are not consistent with the IoM or Levin's out-group feature hypothesis (1996; 2000). As such, it seems unlikely that an in-group/out-group social categorisation model can account for the own-age bias in face recognition.

#### 7.4.3 *A Perceptual Expertise Model*

The final type of account that has been put forward to explain the own-age bias in face recognition is one that suggests that increased exposure to own-age faces allows us to develop more proficient processing strategies for those faces (see Chapter 6). This type of explanation has most commonly been used to explain the own-race bias, with better own-race recognition for faces purporting to be the result of enhanced perceptual expertise for those, compared to other-race faces (e.g. Rhodes et al, 1989). Exactly what these strategies may be is still debated in the literature, however this own-race recognition advantage is most likely to be the result of a more robust representation (e.g. Valentine, 1991) and/or enhanced configural/holistic processing of own-race faces (e.g. Hancock & Rhodes, 2008; see Section 1.8.3. for a discussion of the role of configural processing in expertise).



As discussed in Chapters 5 and 6, while a perceptual expertise account of the own-race bias may be an intuitive one, it is less so when considering it as a suitable account for the own-age bias. As this account is an experience based theory, it runs into similar problems as the contact hypothesis (see Section 9.3.). Specifically, the fact that age is not a stable characteristic at first sight appears problematic. Thus, while such explanations can provide a satisfactory account of why children or adults may be better at recognising own-age faces compared to those older than themselves (i.e. those belonging to an age band which they have not yet belonged to and thus have not had much experience of), they struggle to account for an own-age bias where other-age faces comprise those younger than the participants. This is because participants presumably had ample opportunity to develop the most effective mechanisms for processing younger faces when they once belonged to that age group. However this type of explanation would be plausible if one allows for the possibility that it is recent exposure that is important in the development of and maintenance of this expertise. As facial adaptation studies have shown that recent exposure can significantly affect our subsequent perception of faces (see Clifford and Rhodes, 2005), this type of caveat is certainly plausible.

An "improved perceptual processing" account for recently encountered faces could put forward a number of predictions. Firstly, this kind of theory would predict better recognition of own-age faces compared to those older than the participants (as seen in the child participants in Chapter 2). And secondly, this would explain an own-age bias in participants viewing own-age and younger faces, if their experience for the younger age group had not been maintained (as seen in the undergraduate participants in Chapters 2, 3 and 5). In addition, the large amount of experience that teachers have

with children's faces would be expected to result in perceptual expertise for these, as well as own-age, faces. As such, this theory would predict a reduced (or absent) own-age bias in face recognition in this group (as seen in Chapters 3 and 4).

In addition to these predictions, if perceptual expertise is the mechanism underlying the own-age bias, then specific hypotheses can be made about the type of facial information that is being processed in own- and other- age faces. As discussed in Chapter 1, perceptual expertise is thought to be the result of being able to efficiently utilise the configural information contained in the face (e.g. Diamond & Carey, 1986). Therefore, if we are more expert with one group of faces than another, one might expect recognition of those faces to be impaired to a greater extent by manipulations that disrupt the configural information in these faces. This has certainly been shown to be the case in terms of the own-race bias, with inversion, part-whole and composite effects (see Section 1.2. for a discussion of how these manipulations interfere with configural information in face processing) interfering with own-race face recognition to a greater extent than other-race face recognition (Michel et al, 2006a, 2006b; Rhodes et al, 1989; Sangrigoli & de Schonen, 2004; Tanaka et al, 2004, see Section 1.8.1.2. for further discussion of this).

More recently, a similar pattern of results has been found with the own-age bias. For example, Kuefner et al (2008) showed that not only was the recognition of own-age faces more impaired by inversion than other-age faces, but the size of that inversion effect was mediated by inter-age group contact. That is, while undergraduates appeared to be using the configural information to a greater extent in own-age, compared to children's face, those with high exposure to children's faces (i.e. teachers) showed comparable inversion effects for both age groups. However, as pointed out in Chapter

6, it is possible that this latter pattern was the product of two “other-age” effects, as the age of the facial stimuli in the “own-age” group was not successfully matched to that of the high contact participants.

Using successfully matched age stimuli, Experiments 6 and 7 sought to replicate this pattern of results and extend the findings to include children. In line with previous chapters an own-age bias was found in terms of accuracy (and RTs in Experiment 7) for the children and low contact adults, while no such bias was present in the high contact group. In addition, and most important to the perceptual-expertise hypothesis is the fact that inversion eliminated the pattern of enhanced recognition performance for faces with which participants had most recent exposure. These results, like those reported by Kuefner et al (2008), and seen in the own-race bias literature, suggest that the own-age bias in face recognition may be the result of enhanced perceptual processing for own-age faces as a function of expertise. In terms of the developmental psychology literature, children were found to be more affected by inversion for own-age, compared to other-age faces. This suggests that past research which proposes children are relatively poor at recognising faces as a result of less developed configural processing strategies (e.g. Diamond & Carey, 1986) may have been underestimating their face processing abilities (as has also been suggested by Flin, 1985, and George, Hole & Scaife, 2000).

However, as noted in Chapter 6, inversion has been shown to affect featural cues (albeit to a lesser degree) as well as configural information (Mondloch, Le Grand, Maurer, 2002). Thus, to draw firm conclusions about the role of configural processing in the own-age bias, one needs to consider manipulations that tap into these processes while keeping more featural processes constant. To this end, de Heering et al (2009)

used a composite face paradigm (like that described in Section 1.2) to investigate the mechanisms involved in the own-age bias. The authors found that while participants who had low inter-age group experience showed a higher composite face effect for own-age faces than children's faces, teachers (the high contact group) exhibited no difference between the two groups. These findings are indicative of enhanced configural processing for faces with which we have more experience, with configural processes overriding participants' ability to successfully use the identifying featural information in these faces.

To extend these findings, Experiment 8 investigated undergraduate's sensitivity to small configural changes made to the face (like those used by Frieri et al, 2000; Haig, 1984; 1986; Hosie et al, 1988; Kemp et al, 1990; Leder et al, 2001). In this study, changes were made to the vertical positioning of the eyes and nose, as well as the interpupillary distance (I.P.D.). The magnitude of these changes were so small that they were approaching the threshold of visual acuity (identified by Haig and Hosie and colleagues as equating to around a 4% change of the I.P.D.). The purpose of this study was to investigate whether the threshold for recognising changes made to own-age faces was any lower than that for other-age faces (as an enhanced configural processing account of the own-age bias might predict). This did appear to be the case, with participants being able to detect subtle changes at significantly better than chance at a lower level for own-age faces (2% I.P.D.) than other-age faces (4% I.P.D.). In addition, participants performed significantly more accurately for own-age faces when changes were 4% of the I.P.D., the critical level previously identified as a "just noticeable distance" (e.g. Haig, 1984). Thus, when taken with the data from Experiments 6 and 7, it appears that a configural-expertise account of the own-age bias is supported.

However, at least one study has produced conflicting evidence, Perfect and Moon (2005). As described in Chapters 1 and 6, these authors found that inversion not only failed to reduce the own-age bias in face recognition, but instead it magnified it. Why this might be the case is unclear, and without the inclusion of response speed data it is difficult to gain a complete picture of the participants' performance; only considering accuracy data may be masking important differences in the strategies employed by the different participant groups for faces of different ages (Bruce, 1982). However, as the authors did not attempt to control for participants' inter-age group experience, this pattern of results could have been a product of differential other-age experience (as this thesis has demonstrated that contact can have a significant influence on the magnitude of the own-age bias). Indeed, the pattern of results seen in the Perfect and Moon study is certainly not supported by the work contained within this thesis. However, it is worth keeping the existence of these findings in mind when considering the possible mechanisms responsible for the own-age bias in face recognition.

## **7.5 Towards an Understanding of the Processes Involved in the Own-Age Bias**

This thesis has illustrated that contact plays an important role in the mediation of the own-age bias in face recognition (Chapters 2-4). Using the theories put forward to try and explain other own-group biases in face recognition, this thesis specifically sought to investigate whether a perceptual-expertise, social-cognitive or motivational-attentional account may best explain this phenomenon (Chapters 4-6). The findings of the experiments contained within this thesis are summarised in Table 7.1. Overall, the findings of this thesis seem to be most consistent with a perceptual expertise account (Experiments 6-8). However, it also seems likely that motivation to attend to faces (particularly with the goal of individuation) is an important driving factor of this bias (Experiment 4). Specifically, it is the combination of both quantitative and qualitative aspects of exposure that is likely to be most influential in mediating the own-age bias. One possibility that could explain the results contained within this thesis is that perceptual expertise may develop as a result of attention paid to certain groups of faces over others. Which faces are attended to would essentially be driven by social motivations or situation-specific goals (as described by Rodin, 1987). To this end, social-categorisation may play a role in orienting attention towards faces of specific social interest (an idea at least partially supported by the results of Experiment 5). The idea that certain groups of faces are selectively attended to over others is one that has certainly been illustrated in terms of attractiveness (e.g. Langlois et al, 1987; Langlois, Ruggman & Rieser-Danner, 1990). Indeed, attractiveness is a social cue that Rodin predicts will serve as an important social attention or disregard cue. It follows that this

**Table 7.1 Summary of experiments and their findings**

		Is there an OAB?				Which theory is supported by findings?
	Group	Corrected $\alpha$	$d'$	$c$	$RT$	
Experiment 1	Young Adults	p=.05 (1-tailed)	<.05*	<.05*	≤.001*	
	Children		<.001*	ns	ns	
Experiment 2	High Contact Adults	p=.025 (2-tailed)	ns	ns	<.001*	The Contact Hypothesis
	Low Contact Adults		ns	ns	<.001*	
Experiment 3	Control Group (LC)	p=.017 (2-tailed)	<.01*	ns	<.001*	The Contact Hypothesis; highlights importance of frequency of contact
	Primary Teachers (HC)		ns	ns	ns	
	Secondary Teachers (HC)		ns	ns	ns	
Experiment 4	Control Group	p=.0125 (2-tailed)	<.01*	ns	≤.01*	The Contact Hypothesis; suggests quantitative aspects of exposure may not be as important as qualitative aspects of exposure. Support was found for a Motivation-Attention account of the OAB, but the most support was for an account that included both quantitative aspects of exposure and qualitative, motivational-attentional aspects
	Exposure Group		<.01*	ns	<.01*	
	Motivation Group		ns	ns	<.05	
	Exposure & Motivation Group		ns	ns	ns	
Experiment 5	Gender Classifiaction	p=.025 (2-tailed)	<.05	ns	ns	Mixed support for Social Categorisation was found
	Age Classification		<.05*	ns	<.05	
	Low Contact Adults		<.05		<.001*	
	High Contact Adults		ns		ns	
Does inversion eliminate OAB (if present upright)						
	Group	Corrected $\alpha$	$d'$		$RT$	
Experiment 6	Children	p=.017 (2-tailed)	Yes		n/a	Supports a Perceptual-Expertise Account
	Low Contact Adults		Yes		Yes	
	High Contact Adults		n/a		n/a	
Experiment 7	Children	p=.017 (2-tailed)	Yes <sub>†</sub>		n/a	Mixed support for Perceptual-Expertise was found
	Low Contact Adults		Yes <sub>†</sub>		Yes	
	High Contact Adults		n/a		n/a	
				% <i>Correct</i>	<i>RT</i>	
Experiment 8	Are participants more sensitive to facial changes made to own-age faces?		Yes		Yes	Supports a Perceptual-Expertise Account

\* - indicates significance survived Bonferroni Correction

† - Original OAB only reached nominal significance (p<.05); the effect disappeared using the corrected  $\alpha$  (p<.017)

increased visual input could lead to better representation (e.g. Valentine, 1991) and/ or enhanced configural/holistic processing of these faces (e.g. deHeering et al, 2008; Kuefner et al, 2008; Michel, Rossion, Han, Chung & Caldara, 2006; Rhodes et al.1989; Tanaka, Kiefer & Bukach, 2004). However, there is little evidence of this in the face processing literature and work on potential memory advantages for attractive faces has produced inconsistent results (e.g. Sarno & Alley, 1997; Wickham & Morris, 2003).

However it still seems probable that a combined model including both motivational and experiential aspects could adequately explain the own-age bias in face recognition. Perceptual-expertise models are, by definition, dependent on experience with faces; and the faces with which we have experience are attended to as a result of our social goals and motivations (e.g. Hayden, Parikh, Deaner & Platt, 2007). Thus it seems logical that both the level of motivation one has to attend to other-age faces (possibly determined by social categorisation), and the degree of expertise one has to discriminate between them, are factors that are likely to mediate the magnitude of the own-age bias.



## 7.6 Limitations and Future Directions

While this thesis has highlighted the importance of contact in the own-age bias, and offers evidence that this phenomenon can be explained in terms of motivational and experiential factors, it is important to consider the limitations of such conclusions.

Firstly, there is the issue of generalisability. The majority of participants in this study had particularly high exposure to own-age faces on an almost daily basis (on account of attending university or school). As contact with different age groups has been seen to play a role in mediating the own-age bias, it is likely that this would result in an exaggerated own-age bias for these cohorts (see Table 3.2 for a demonstration of this in the existing own-age bias literature). As such, it is unclear how generalisable these findings are to populations where own-age contact is not as high, and inter-age contact is perhaps more varied. This is an important issue to consider, as the majority of the population do not have such high levels of daily contact with own-age faces. Thus future research should investigate the own-age bias in participants who have a variety of inter-age group contact.

In addition, the experiments contained within this thesis were limited in that they only looked at the ability of young adults and children (aged between 8-11 year old) to recognise young adult and child faces. As such it is difficult to draw broad conclusions that would encompass other age groups. What can be said from these findings is that both age groups appeared to be better at recognising own-age faces (although children performed generally worse than adults). In addition, both groups appeared to be more affected by inversion for own-age faces, suggesting greater expertise for those faces.

Whether these effects exist outside of these age groups is unknown, although previous research suggests that this is the case with middle-aged and older adult groups (e.g. Anstasi & Rhodes, 2005; 2006). However, only three other studies have been carried out with child participants, all of which had methodological flaws (Anastasi & Rhodes, 2005; Chung, 1997; Crookes & McKone, 2009). As such, it would be interesting to investigate whether this phenomenon is present in younger children than in this study. This would allow us to gain further insight into children's face recognition abilities with own-age faces. This is important as this thesis, as well as other work by Feinman and Entwisle (1976) and George, Hole and Scaife (2000), has provided evidence that previous work tracking the development of children's face processing skill may have underestimated their abilities due to the use of facial stimuli belonging to a relatively unfamiliar age group (usually of young adult age). In addition, this would add to the body of work that has been done on the development of other own-group biases in face recognition (e.g. Chance, Turner, and Goldstein, 1982; Corenblum & Meissner, 2006; Cross, Cross & Daly, 1971; Feinman & Entwisle, 1976; Pezdek, Blandon-Gitlin & Moore, 2003; Sangrigoli & de Schonen, 2004; Sangrigoli et al, 2005; O'Toole, Deffenbacher, Valentin, & Abdi, 1994) which can only add to our understanding of such effects.

A further limitation of this thesis is in regard to the stimuli that were used. Again, only child and young adult faces were used throughout this thesis, thus it is unclear how these findings generalise to faces of other ages. This may be a particular issue in this case, as it is unclear to what extent physical differences between the child and adult faces may be responsible for these findings. For example, this thesis

consistently found an own-age bias in face recognition, while other studies (using only adult faces) have found more varied and inconsistent results (see Table 2.1). It is possible that this is due to the fact that there are considerable structural differences between children's and adult's faces, whereas faces of adults at different ages are relatively similar (see Rhodes, 2009 and Section 1.5.1 for reviews). Thus, it might be the case that the findings in this thesis are confined specifically to child and young adult faces. As such, more work needs to be done with facial stimuli of various ages and participants from a range of age groups and contact settings in order to see how generalisable and robust the findings within this thesis are.

In addition to finding an own-age bias in face recognition, this thesis found that this effect is mediated by contact. Specifically, results appeared to support a perceptual expertise and motivational account of this bias. Intuitively, it seems likely that motivation to attend to own-age faces, and the subsequent visual input from those faces, leads to the development of more efficient strategies to process faces belonging to one's own age group (namely using more "expert", configural processing). However, using the inversion effect to investigate this is slightly problematic, as inferring greater configural coding of own-age faces based on larger inversion decrements for those faces assumes that inversion selectively disrupts configural information (Diamond & Carey, 1986). Yet previous studies have shown that inversion also impairs featural/component coding, albeit to a lesser extent (e.g. Mondloch, Le Grand & Maurer, 2002). As such, the presence of an inversion effect may not simply reflect a disruption of configural processing, but may in fact be the result of "some unknown combination of impaired configural, component, and holistic coding" (Rhodes, Hayward & Winkler, 2006). The

final experiment in this thesis sought to rectify this issue by investigating participant's sensitivity to configural changes, while keeping the featural information constant.

While it was found that participants were more sensitive to changes made to own-age faces compared to other age faces, supporting a configural-expertise account of the own-age bias, it is possible that these results are the product of configural changes being generally harder to detect in children's faces than in adults' faces. To establish whether or not this is the case, future research could investigate whether participants of different ages, or those with high inter-age group contact, show this increased sensitivity to configural changes made to own-age faces.

In addition, in order to gain further insight into the underlying mechanisms involved in the own-age bias, future research should consider studying the neural basis of this phenomenon. To date research on the own-age bias has mainly concentrated on the behavioural aspects of this memory bias and has suggested that it may be the result of increased exposure to and increased interest in faces of our own age (as demonstrated within this thesis). In terms of the own-race bias literature, differential activation of the fusiform face area (FFA) has been demonstrated for own- and other- race faces, with own race faces eliciting higher activation (Golby et al, 2001). As noted in Section 1.1, while some researchers believe this area of the brain is an innate, highly specialized region for processing faces, others have demonstrated that it is not face-specific per se, rather it is an area involved in the individuation of members of a homogeneous class that, through practice, we have become experts at distinguishing between (Gauthier et al, 1999; Gauthier et al, 2000). As such, the increased activation patterns Golby et al

(2001) observed for own-race faces may have been result of greater expertise with those faces.

Along similar lines as the Golby et al (2001) study, in order to further investigate whether or not the own-age bias is truly modulated by expertise, future research in this area could investigate the neural substrates underlying the differences in memory for own and other age faces. Not only would this research shed further light on the cognitive processes involved in the own-age bias, but may also provide further insight into the role expertise has in FFA activation and face processing in general. If the OAB is truly moderated by expertise, then we would expect greater FFA activation for own-age faces than other-age faces (see Golby et al, 2001).

## **7.7 Implications**

This thesis sought to investigate the own-age bias in face recognition using previous research into other, similar biases (i.e. the own-race bias and the own-gender bias) as a starting point. While this thesis never claimed that these three biases were necessarily analogous, the work contained within the previous chapters has shed some light on this issue. Throughout the own-race bias literature it has been noted that the recognition advantage for own-race faces is usually accompanied by a more conservative response criterion for those faces (e.g. Meissner & Brigham, 2001; Sporer, 2001). However, while this thesis has demonstrated a similar own-group pattern in terms of increased accuracy for own-age faces, no parallel can be drawn in terms of the

response bias data. Thus, it may be that the two biases are not a product of the same underlying mechanisms.

While the pattern of increased accuracy for own-age faces without differential response criteria for own-age and other-age faces mirrors the pattern witnessed in the own-gender bias literature (e.g. Shapiro & Penrod, 1986), again it seems that these biases may not be analogous. Research into the own-gender bias has suggested that a feature-based processing theory may best account for this bias (e.g. Wright & Sladden, 2003), while this thesis has demonstrated that the own-age bias is most likely the product of increased motivation to attend to own-age faces, resulting in better configural processing for those faces. As such, it seems that these three biases may not be analogous, as sometimes suggested in the face recognition literature (e.g. Sporer, 2001; Wright & Stroud, 2002). However, this thesis did not seek to directly compare these biases in face recognition, so there is a limitation to the conclusions that can be drawn at this stage. Before firm conclusions can be drawn about the relationships between the own-group biases in face recognition, further research need to be carried out.

This thesis has demonstrated an own-age bias in face recognition in young adults and children for similarly aged faces and shown that this is mediated by inter-age group contact. As Wright and Stroud (2002) pointed out, this effect could have important implications in terms of eyewitness testimony. Most previous research investigating age effects in eye-witness testimony has only considered the age of the witness, and not that of the perpetrator, or an interaction between these two variables (see Section 1.7). This thesis has provided evidence that this might be a mistake, as failing to account for an own-age bias in face recognition may mean that participant's

eyewitness abilities are being underestimated (as in Adams-Price, 1992; Bartlett & Leslie, 1986; Fulton & Bartlett, 1991). In terms of real-world implications, knowledge of the own-race bias has been crucial in the legal system where the possibility of identification errors is likely (e.g. Brigham & Malpass, 1985; Meisner & Brigham, 2001; Sporer, 2001) and has been identified by expert witnesses as being a reliable enough phenomenon to be presented in court (Kassin, Tubb, Hosch & Memon, 2001). Similarly, if the own-age bias proves to be a robust finding, existing in a number of age groups in a variety of settings, then this has obvious implications for law enforcement as well as the justice system with regard to eyewitness testimony.

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